ENVIRONMENTAL IMPACT ASSESSMENT

AQUATIC STUDY

ROSS BAY JUNCTION - CHURCHILL FALLS TOTE ROAD

TRANSPORTATION

GOVERNMENT OF NEWFOUNDLAND & LABRADOR

GOVERNMENT OF NEWFOUNDLAND AND LABRADOR
DEPARTMENT OF TRANSPORTATION

Office of the Minister
Telephone 737-3641

ST. JOHN'S

File No. PR/71

MAR 0 5 1986

Honourable John Butt, M.H.A.
Minister,
Department of Environment
Elizabeth Towers
100 Elizabeth Avenue
St. John's, NF
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Dear Colleague:

RE: Aquatic Study Report - Ross Bay Junction to Churchill Falls Tote Road Environmental Assessment

In accordance with Section 9 (10) of the Environmental Assessment Regulations, 1984, I am enclosing twenty-five (25) copies of the Aquatic Component Study Report for the Ross Bay Junction to Churchill Falls Tote Road Environmental Assessment. This report was prepared by LGL Limited.

The views and recommendations presented herein are those of the consultant and do not necessarily reflect the policies and procedures of the Department of Transportation.

The information contained in this report relates specifically to the Aquatic Component. There are six (6) additional component studies as well as an Environmental Impact Statement. Any views or comments which are expressed about this report should consider the other component studies and moreover, the Environmental Impact Statement which, in addressing the overall environmental impacts of the proposed project as documented in the component studies, will provide the clear statement of the policies and procedures of the Department of Transportation with respect to this project.

(...../2)

My department looks forward to your review and examination of this report.

If you have any questions, please do not hesitate to contact me or my staff.

Sincerely,

RON DAWE
MINISTER OF TRANSPORTATION

/dm
Enclosures

ROSS BAY JUNCTION TO CHURCHILL FALLS TOTE ROAD

ENVIRONMENTAL IMPACT ASSESSMENT:

AQUATIC STUDY

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DEPARTMENT OF TRANSPORTATION
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EXECUTIVE SUMMARY

The Labrador tote road will provide a road link between Wabush-Labrador City and Churchill Falls. Two routes have been considered: the proposed route which follows a more or less direct path between Ross Bay Junction and Churchill Falls and the alternate route which roughly parallels the existing Quebec North Shore and Labrador Railroad then joins with an existing haul road near Esker. The alternate route would require the construction of less new road but the preferred route would provide a shorter driving distance.

The present aquatic resources study is one of the component studies required for the provincial environmental assessment process. The present study, which was based upon terms of reference prepared by the Newfoundland and Labrador Department of Transportation, was designed to determine the quality and distribution of fish resources and fish habitat along both tote road corridors. This study included aerial reconnaissance to classify and map fish habitat in waterbodies within the tote road corridors and more detailed habitat description and fish population assessment at 18 sites on the proposed route and 6 sites on the alternate route. These sites for more detailed investigation were selected jointly by Department of Transportation and Canada Department of Fisheries and Oceans. Fish population assessment at stream crossings consisted of electrofishing, angling, beach seining and/or gillnetting. All fish caught were identified, measured and weighed and scales were retained from brook trout for age determination.

Fish species sampled at stream crossings were brook trout (Salvelinus fontinalis), burbot (Lota lota), lake chub (Couesius plumbeus), longnose dace (Rhinicthys cataractae), longnose sucker (Catostomus catostomus),

northern pike (Esox lucius), sculpins (Cottus bairdi and C. cognatus), and white sucker (Catostomus commersoni). Of the above, only brook trout and northern pike are potentially valuable for recreational fisheries. Other potentially valuable species previously recorded in this area but not sampled during the present study are lake trout (Salvelinus namaycush), lake whitefish (Coregonus clupeaformis), and ouananiche (Salmo salar). These latter species may be present in several larger lakes within the study corridor but which were not included in this study.

At present, there is very little angling activity within either the preferred or alternate corridors. The Ossokmanuan Reservoir bridge and causeway will likely provide the best recreational fishery along either of the routes, with lake trout, ouananiche, and pike being the principal species sought. Several rivers along both routes have the potential to provide good angling for small brook trout, since no large brook trout (for which Labrador is noted) were encountered during this study.

Relatively little potential spawning habitat was identified near the proposed tote road crossings along either route, but both routes include crossings situated in steep areas where migration could be critical.

The possible impacts on fish resources resultant from the tote road could be caused by siltation (p. 18), gravel removal from floodplain areas (p. 20), blasting (p. 21), sewage, garbage or chemicals originating from construction camps and maintenance facilities (p. 20, 21), fuels and lubricants (p. 21), stream obstruction by poorly designed or placed culverts (p. 23-25), and increased harvest (p. 22).

Of the above, the most serious long-term impact is most likely to be caused by improperly installed stream crossing structures. Two factors are essential in constructing a stream crossing which will not obstruct fish

migration:

1. adequate capacity -- A bridge or culvert which is underdesigned and severely constricts the watercourse will, without exception, cause fish passage problems due to extremely high current velocity. These structures are also likely to cause scour which may cause chronic downstream siltation.

2. proper placement -- This concern refers almost exclusively to culverts. Culverts placed at a steep slope or culverts installed such that a hydraulic jump is created will usually be impassable to upstream-migrating fish.

If such an obstruction is created, significant decreases in fish production could conceivably occur.

Most of the potential impacts identified above may be mitigated through proper design and good construction practices. The impact of sedimentation may be minimized by

1. leaving buffer strips between the road and adjacent waterbodies (p. 29),
2. diverting streams around work areas using sandbag dikes,
3. performing any channel modifications from shore using a backhoe rather than a bulldozer in the stream,
4. limiting instream activities to the least critical time period for fish (June 15 to September 1), and
5. stabilizing disturbed streambanks and cuts or fills adjacent to a watercourse to prevent erosion of silt into the stream.

No blasting at watercourse crossings should be permitted when concentrations of migrating fish are present. All potentially deleterious substances (e.g., sewage, garbage, chemicals, fuels, etc.) should be handled and/or stored in accordance with appropriate environmental guidelines. All watercrossing structures should be designed and installed such that they do not prevent or hinder fish movements (p. 30,31). In many cases, impact may be greatly decreased by relocation of the road centerline to cross a stream

where the bed slope is minimal. This will greatly reduce any potential fish passage problems. Impact on fish populations as a result of increased harvest may only be mitigated by proper surveillance and enforcement by conservation authorities.

The three possible tote road scenarios (1) summer road, (2) all year round, and (3) connection to the national highway network were considered to have little affect on fishery impacts, except that increased traffic which may occur during the third scenario could increase sport fishing pressure. Similarly, provided that adequate structures are installed on all watercourse crossings, and slopes are stabilized to prevent sustained erosion, no additional impacts are anticipated as a result of road operations during the first ten years.

In order to monitor the effects of this project and mitigative measures, all watercourse crossings should be inspected during construction by an environmental monitor to ensure adequate mitigative procedures are being employed by the contractors. Subsequently the crossings should be inspected during suspected migration periods to ensure all structures are operating as required.

A brief summary of perceived impacts, mitigations and monitoring strategies are presented in Table A.

Table A. A summary of possible impacts and proposed mitigation.

Source of Impact	Description	Mitigation Proposed	Monitoring Proposed
During Construction			
Siltation and sedimentation	Loss of critical spawning and rearing habitat. Mortality of eggs and alevins. Decreased feeding efficiency and reduced growth of salmonids. Lower density and diversity of aquatic invertebrates. Sensitive areas (critical habitat and erodible soils) --Preferred route km 85.5 and km 116.5 --Alternate route km 121.5 and km 14.5.	Minimize instream activity by working from shore with a backhoe. Divert flow around work area. Stabilize cuts and fills to minimize erosion. Maintain buffer zones along waterbodies. Divert runoff into settling basin or alternative. Restrict instream activity to summer period when eggs and fry are less vulnerable to sedimentation.	On site environmental monitor to ensure good practices are followed.
Wastes and Sewage	Increased organic loading to watercourses causing reduction of water quality. Possible fish toxicity or contamination.	Sewage should receive primary treatment and effluent not to be discharged in or near a watercourse. Waste disposal restricted to approved landfill sites.	On-site monitor to ensure compliance with regulations.
Fuels and Lubricants	Toxic to fish and aquatic life. Contamination of fish at sublethal levels.	Store fuels and lubricants in leak proof tanks. Bulk depots should be surrounded by impermeable berm to contain spills. Prohibit refueling or maintenance within 100 m of any waterbody. Ensure good equipment maintenance to prevent leaks of fuels, lubricants or hydraulic fluid.	

Table A continued.

Source of Impact	Description	Mitigation Proposed	Monitoring Proposed
Blasting	Direct fish mortality. Possible severe sedimentation.	Timing constraints required on a site-specific basis.	
Two Years Post-Construction			
Increased Harvest	Local depletions in sport fish abundance.	Adequate management and enforcement by regulatory authorities.	
Sustained Siltation	Loss of critical habitat. Failure of recruitment in impacted area. Decrease in growth and abundance of desirable species.	Stabilization of cuts, borrow pits and other cleared areas to prevent erosion. Installation of adequate crossing structures to prevent scour.	Inspection to ensure adequate stabilization.
Migration Obstruction	Delay or prevent access of fish to upstream habitat. Produce concentrations of fish downstream that are vulnerable to overfishing. Sensitive areas (probable migration routes) --Preferred route km 85.5, 157.0, 160.5, 186.0, 194.5 --Alternate route km 86.5, 103.5, 120.5, 121.5, 130.0, 147.5.	Installation of adequate crossing structures in accordance with DFO guidelines.	Inspection of all culverts to ensure adequate fish passage capability.

Table A continued.

Source of Impact	Description	Mitigation Proposed	Monitoring Proposed
Ten Years Post-Construction			
Increased Harvest	Local depletions in sport fish abundance.	Management and enforcement by regulatory authorities.	
Sustained Siltation	Possible loss or depletion of important fish stocks.	Stabilization of erodible areas to prevent siltation.	Periodic inspections.
Migration Obstruction	Exclusion of fish from critical habitat could result in loss of some fish stocks.	Ensure that crossing structures are adequate for fish passage.	Periodic inspections to ensure fish passage capability is maintained.

ACKNOWLEDGEMENTS

The following people assisted in or participated in the successful completion of this project. Mr Mike Furey provided much appreciated assistance during the field program. Special thanks are due to Mr. Charles Alexander of Lobstick Lodge whose efforts hauling helicopter fuel, providing meals at odd hours and in providing a pleasant living atmosphere greatly facilitated our field program when the weather was less than ideal.

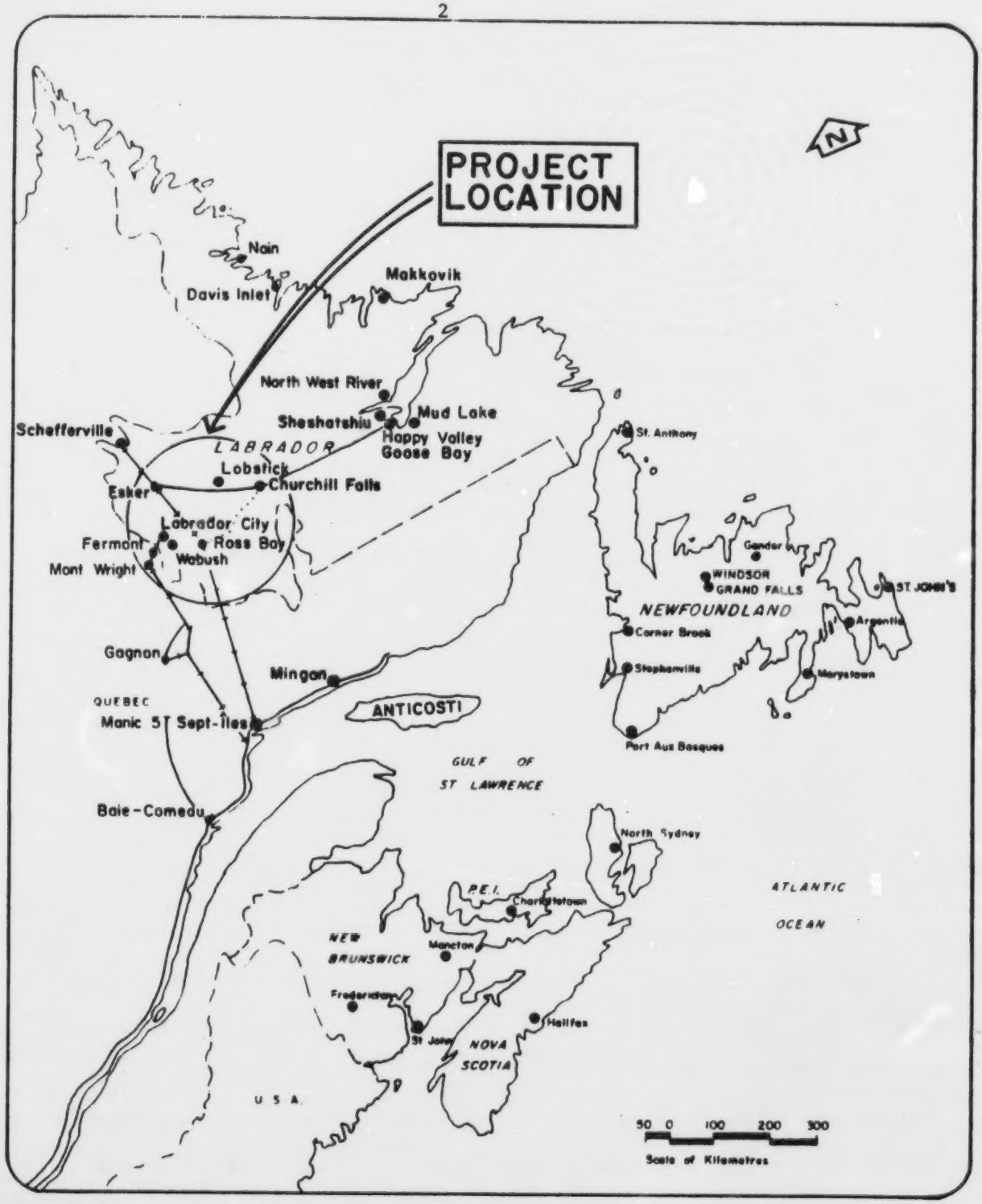
The efforts of Mr Rick McCubbin, D.F.O., and Mr. Roger Pottle, Department of Transportation, who selected and flagged crossing sites requiring detailed study, also facilitated the success of the field program. A photographic record of all sites compiled during this initial reconnaissance proved to be very useful in planning our field studies.

Mr. Robert Buchanan (LGL Limited), Mr. Geza Teleki (Delcan), Mr. Roger Pottle (Department of Transportation) and Dr. Greg Pope (Pope and Associates) provided advise and editorial input during the preparation of this report. Ms. Judy Hindy diligently typed this manuscript, and original figures included in this report were drafted by Lundrigan and Crowley Ltd. Finally, the co-operation of the project manager, Mr. Tim Houlihan of Delcan, throughout the project is gratefully acknowledged.

1.0 INTRODUCTION

The Labrador tote road has been proposed by the Newfoundland and Labrador Department of Transportation to provide a road link between the upper Lake Melville area and Wabush-Labrador City. Only one segment of the road between Ross Bay Junction and Churchill Falls is yet to be constructed (Figure 1). Two routes have been considered: the proposed route which follows a more or less direct line between Ross Bay Junction and Churchill Falls and the alternate route which roughly parallels the Quebec North Shore and Labrador (QNS and L) Railroad from Ross Bay Junction and connects with the existing Esker haul road, currently maintained by Churchill Falls Labrador Company (CFL Co.). The latter route would require construction of less new road (90 km vs 130 km) but the proposed route would provide a shorter total driving distance (approximately 60 km less).

The present aquatic resources study is a component of an environmental impact assessment of the proposed tote road as required by the Department of the Environment. The study design was based upon terms of reference prepared by Newfoundland and Labrador Department of Transportation. The principal objectives were to determine the availability and quality of fish habitat along both highway corridors and to conduct site-specific surveys at selected locations along each route. The data compiled during the field program and information available in the literature were used to assess the impact on aquatic resources of both the proposed and alternate routes. A mitigative strategy was developed from both a literature review and field data collected during this study. In addition, a monitoring program designed to ensure minimal impact on aquatic resources has been recommended.



ROSS BAY JUNCTION - CHURCHILL FALLS TOTE ROAD

Figure 1. Map of Atlantic Canada illustrating location of study area.

2.0 APPROACH

Aquatic investigations were conducted along the proposed and alternate routes of the Labrador tote road from 23 to 31 July 1985. These studies consisted of two levels of investigation:

1. reconnaissance-level habitat mapping of watercourses within the tote road corridors, and
2. more detailed site-specific investigations of selected stream crossings.

These latter crossings, 18 on the proposed route and 6 on the alternate route, were selected by Canada Department of Fisheries and Oceans (DFO) and the Department of Transportation during earlier reconnaissance.

The first order habitat mapping was performed visually from the air (helicopter). Stream habitat was classified into the following general categories based upon substrate type, apparent velocity, depth and available cover:

Type 1. Salmonid (trout and ouananiche) spawning and rearing habitat -- gravel substrate, low to moderate current velocity, relatively shallow (<1 m).

Type 2. Salmoid rearing habitat -- cobble-boulder substrate, moderate current velocity, depth shallow (<1 m).

Type 3. Poor fish habitat -- large boulder or bedrock substrate, high velocity with extensive "white water", depth variable.

Type 4. Adult salmonid and pike habitat -- substrate frequently sand or silt, very low velocity or standing water, usually >1 m deep.

Type 5. Poor fish habitat -- poorly defined or obstructed stream.

Lakes were visually classified as shallow, moderate or deep whenever visibility was adequate. Heavy cloud cover and frequent precipitation during much of this field program hampered both lake and stream habitat classification, by restricting visibility and by increasing stream flow.

At each site selected for more detailed investigation, the following data were compiled in the vicinity of the proposed crossing:

1. bank vegetation,
2. bank composition and apparent stability,
3. bank height,
4. stream gradient, and
5. stream substrate composition and stability.

In addition, stream depth and velocity were measured on a transect across each watercourse. These data were subsequently used to compute stream discharge. Due to high flows prevalent during the present study, depth and velocity transects were not possible in some of the larger rivers. In these cases, surface velocity was measured using a floating stick and stop watch; mean depth and width were estimated visually.

Fishing was attempted at each of the study sites selected for detailed investigation. In most cases, electrofishing was conducted with a Smith Root Type VIIIa electrofisher. Electrofishing was replaced or augmented by angling, beach seining or gillnetting at some sites. In all cases, both catch and effort were recorded. All fish captured were identified, measured and weighed; with the exception of a few gillnetted and angled individuals, all were released alive. Scale samples were retained from brook trout for

age-growth analysis. In the laboratory, scales were cleaned and examined under a dissecting microscope using transmitted light and the scale annuli were counted to determine fish age.

Impact of the project was assesed both within the individual watersheds affected by each river crossing and along the route as a whole. Impact projections were based on three possible road operation scenarios:

1. summer road only,
2. year-round maintenance, and
3. national highway connection.

These impacts were assessed for the construction period and for two and ten years after the completion of the project. The following terms were selected from the list provided by the project manager (DelCan) at the initial meeting and defined within the framework of the aquatic study.

Short-term impact refers to an impact, the effects of which would be limited to the actual period of construction and within one year thereafter.

Long-term impact refers to impacts that are sustained or those with residual effects lasting longer than one year after construction.

Significant impacts may be manifested in two ways:

1. depletion of a valuable fish resource, and/or
2. degradation of physical or chemical conditions within a watercourse which would adversely affect either fish production or use of the watercourse by humans or other wildlife.

Minor impact is a small or short-term change in the relative abundance of an important fish species or a temporary decline in habitat quality.

Major impact is a drastic decline in the abundance of an important fish species such that it would be no longer able to support a recreational or a traditional domestic fishery. In terms of habitat, a major impact would be either a migration barrier or severe habitat degradation such that future fish production would be reduced.

Important species are those fishes valued by either recreational, domestic, or commercial fisheries. In the study area, these include brook trout (Salvelinus fontinalis), lake trout (S. namaycush), ouananiche (Salmo salar), northern pike (Esox lucius), and lake whitefish (Coregonus clupeaformis).

3.0 EXISTING CONDITIONS

3.1 Fish Resources

3.1.1 Species Distribution and Relative Abundance

The following fish species were collected at stream crossing sites during field investigations:

brook trout	Salvelinus fontinalis
burbot	Lota lota
lake chub	Couesius plumbeus
longnose dace	Rhinichthys cataractae
longnose sucker	Catostomus catostomus
northern pike	Esox lucius
slimy and mottled sculpin	Cottus cognatus and C. bairdi
white sucker	Catostomus commersoni

Slimy and mottled sculpin were not distinguished due to the difficulty in differentiating between small individuals of these similar species, both of which have been previously reported from western Labrador (Scott and Crossman 1973).

Brook trout and northern pike were the only fish encountered during this study that are potentially valuable to recreational fisheries. All of the other fish species are either forage fish or are considered undesirable species for a sport fishery. Some other valuable fishes that have been previously reported from the Smallwood Reservoir and the larger rivers and lakes of western Labrador are lake trout (Salvelinus namaycush), lake whitefish (Coregonus clupeaformis), and ouananiche (Salmo salar). It is highly likely that these species may be present in several of the larger and deeper lakes situated adjacent to the proposed and alternate routes of the

Labrador tote road, but sampling of these waterbodies was not included in the terms of reference. Brook trout were the most frequently sampled species along the proposed route occurring in 13 of the 18 sites sampled (Appendix 1). However, they were considered to be relatively abundant at only one site, km 70.5 and common at only four sites. At most of the proposed crossing sites, non-game fishes were predominant in electrofisher samples.

Along the alternate route, brook trout, lake chub, and sculpin occurred at five of the six sites sampled (Appendix 2). Brook trout were considered to be abundant at only two sites and, as was the case along the proposed route, non-game fishes were usually the predominant constituent of the fish community.

3.1.2 Brook Trout Biology

All brook trout sampled during the present study were combined for analysis of age and growth since no single collection was large enough for meaningful analysis. A length-frequency plot (Figure 2) revealed that the brook trout sampled were comprised of five size classes which more or less corresponded to the ages of brook trout in the sample, 0+ to 4+. Few fish in the sample were large enough to be acceptable to sport fishermen. The age-length relationship (Figure 3) suggests that the growth rate in most of these streams is similar to that reported from the Valley River (Wheeler 1977) but much slower than that reported from Jacopie Lake (Bruce 1974). This suggests that brook trout sampled along both the proposed and alternate routes of the Labrador tote road are not members of fast-growing populations that are indigenous to some rivers and lakes in Labrador. It is these other

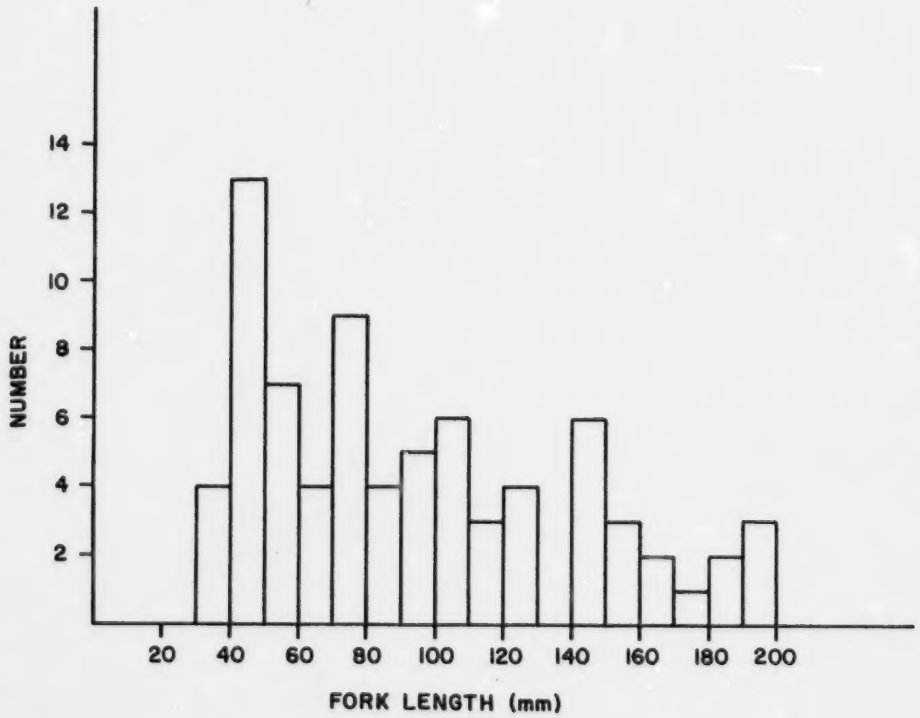


Figure 2. Length-frequency of brook trout sampled along the preferred and alternate routes of the Labrador tote road during the present study.

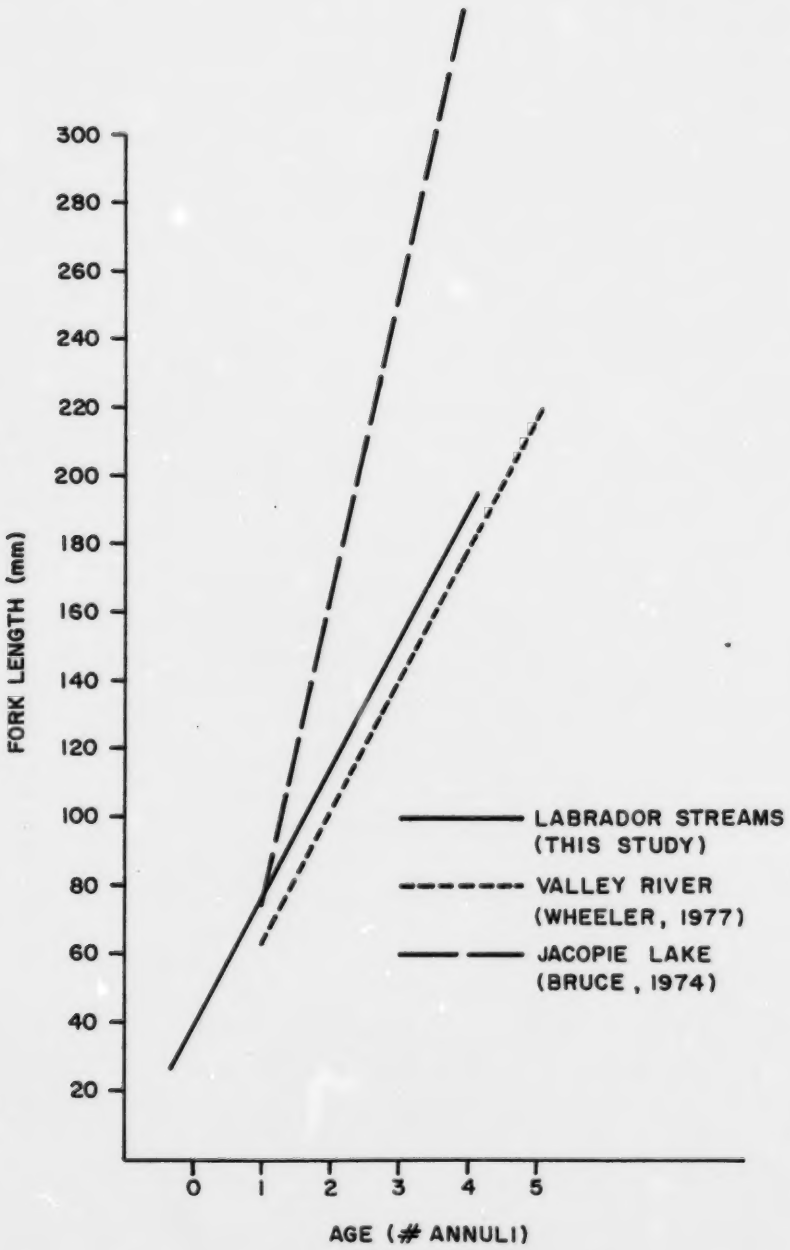


Figure 3. Age-length relationship of brook trout sampled during the present study compared to other locations in Labrador.

fast growing populations which, due to their large size fish, are most prized by sport fishermen in Labrador.

3.1.3 Resource Utilization

At present, relatively little angling occurs along the proposed route. During the field program, anglers were observed fishing on a small unnamed lake near km 71.5 which is presently accessible from Wabush by an existing road to a communications tower. In addition, some local residents have transported light aluminum boats beyond the end of the existing road (km 70.0), most probably to fish Embro Lake and some adjacent small ponds, all of which are situated near the proposed road. No angling activity was observed along the alternate route during the field program but several sites are presently accessible via the QNS and L Railroad.

Larger lakes adjacent to both the proposed and alternate routes of the tote road will likely provide angling opportunities for brook trout, lake trout, and northern pike. Some larger lakes which are likely to provide good angling along the proposed route are Embro Lake (km 77) and unnamed lakes at km 133 and km 138. Most other lakes adjacent to this route are either small or shallow (hence winterkill would likely preclude resident fish) or are situated too far from the road to provide ready access to sport fishermen. Ossokmanuan Reservoir will probably provide some of the best angling opportunities along the proposed route. The principal sport fish in this waterbody is lake trout which accounts for 15.8% of numbers and 57.9% of biomass (Bruce and Parsons 1979). Ouananiche were also present but accounted for less than 1% of the numbers and biomass of fish sampled in the reservoir. Nevertheless, it is probable that ouananiche will be a significant constituent of a sport fishery since the species is very popular

with anglers, a world record having been taken recently from the Lobstick area. Northern pike are relatively common in Ossokmanuan Reservoir, comprising 5.9% of numbers and 14.1% of biomass (Bruce and Parsons 1979). However, northern pike are not valued by Labrador sport fishermen at present given the relative abundance of more desirable salmonids. The species, however, is very popular among anglers from central Canada and the U.S.A. and as a result has considerable potential to become an important constituent of a sport fishery.

Lake whitefish are also abundant in Ossokmanuan Reservoir and have the potential to support a commercial fishery (Bruce and Parsons 1979). This potential fishery has been examined as part of a Smallwood Reservoir fishery both from a biological perspective (Bruce 1975, 1984) and from a socio-economic perspective (Jones 1976). Both studies suggest that a fishery would be possible for this resource but to date no such fishery has been successfully established. Annual commercial landings have been less than 2000 kg per year but little effort has been expended by the indigenous population (pers. comm., T.R. Porter, DFO).

The value of the fish resource in Smallwood Reservoir is further complicated by mercury contamination of lake trout and northern pike which exceed those levels established for commercial sale of fish (Bruce and Spencer 1979). This mercury contamination probably results from the biomagnification of naturally occurring mercury. Increased mercury concentrations are frequently reported in fish resident in relatively new reservoirs, but to date no mechanism has been identified to adequately explain the phenomenon (Jones et al. 1986). The fish with the highest mercury contamination were mostly sampled in the Lobstick area rather than in the immediate vicinity of either of the tote road routes (unpublished data, DFO). The mercury concentrations of fish in the Lobstick area are

under study by DFO, but there are no plans at this time to prohibit sport fishing in the area. It is highly unlikely that the proposed Labrador tote road would have any effect on mercury concentration in fish in the project area. It is also unlikely that mercury in fish from the Lobstick area will have any effect on the viability of the recreational fishery along the tote road route.

3.2 Habitat Assessment

3.2.1 Proposed Route

The distribution of fish habitat types within the corridor of the proposed route is presented in map sheets 1 to 7, Appendix 1. It is possible that the relative amount of Type 3 habitat has been overestimated in these aerial surveys since many rivers were in flood during our field surveys and, as a result, water velocity was higher than normal. Habitat types recorded near the intensive survey sites were as follows: Type 2 - 11 sites, Type 3 - 8 sites, Type 4 - 5 sites and Type 5 - 1 site (Appendix 2). The total of the above is more than the 18 sites examined because more than one habitat type was associated with several crossings. Relatively little potential spawning habitat was identified near any of the proposed crossing sites. Physical habitat measurements recorded at 18 selected crossing sites are summarized in Table 2 (greater detail is provided in Appendix 2). These watercourses include very small, poorly defined drainages (e.g., unnamed stream km 111.5) and medium-sized rivers (e.g., Miron River, km 85.5 and Valley River, km 194.5).

The largest waterbody crossed on this route, namely Ossokmanuan Reservoir, was not examined since little useful information could be gathered on a large waterbody during a brief study.

3.2.2 Alternate Route

The alternate route between Ross Bay Junction and the CFL Co. Esker road closely parallels the QNS and L Railroad between km 70 and km 115, then diverges for the next 40 km to pass through a previously undisturbed area. Fish habitat mapping within this corridor is presented in map sheets 8 to 12, Appendix 1. Good salmonid habitat (Type 2) was identified near the proposed crossings of Bernadette River (km 103.5), Evening River (km 121.5), and unnamed river (km 147.5). This latter site also included potential spawning habitat (Type 1) both up and downstream of the proposed crossing. Type 4 habitat was identified at two of the six sites and Type 3 habitat was identified at the Miron River crossing (Appendix 1). Physical habitat measurements at six selected sites are summarized in Table 3 (greater detail is provided in Appendix 2).

Table 2. A summary of the biological and physical data measured at selected stream crossings along the proposed route of the Labrador tote road.

Km	70.5	72.0	77.5	82.5	85.5	88.5
Watercourse	unnamed	unnamed	unnamed	unnamed	Miron R.	unnamed
Maximum depth (cm)	56	51	26	>100	-	69
Mean depth (cm)	34.5	24.7	16.4	66	100	38.7
Max velocity (m/s)	.45	.23	.88	.22	-	.5
Mean velocity(m/s)	.025	.108	.56	.161	1.7	.287
Width (m)	9	3	16	15	10	12
Discharge (m /s)	.078	.08	.5	1.59	17	1.33
Gradient (%)	.1	.4	.5	.1	.9	.3
Substrate type	boulder	cobble	boulder	boulder	bedrock	boulder
Apparent stability	stable	stable	stable	stable	fair	stable
Bank height (m)	<1	<1	<1	<1	3-4	<1
Bank slope	gentle	gentle	gentle	gentle	steep	gentle
Bank composition	organic	organic	organic	organic	bedrock	organic
Bank vegetation	shrubs	spruce	spruce	spruce	spruce	shrubs
Riparian cover	nil	extensive	little	fair	little	minimal
Habitat type	type 2&4	type 2&4	type2	type2	type3	type2
Salmonid abundance	abundant	rare	rare	common	present	rare
Sensitive areas	spawning downstream	none noted	none noted	spawning area	rearing downstream	none noted

Table 2. Continued

Km	103	111.5	114	116.5	122	126.5
Watercourse	unnamed	unnamed	unnamed	unnamed	unnamed	unnamed
Maximum depth (cm)	34	35	58	57	76	53
Mean depth (cm)	21.2	26.5	42.3	28.9	54.4	34.1
Max velocity (m/s)	.68	.34	-	-	.39	.93
Mean velocity(m/s)	.412	.125	1.4	1.9	.206	.49
Width (m)	4.5	5	12	12	15	15
Discharge (m /s)	.39	.13	7.1	6.6	1.68	2.5
Gradient (%)	.6	.1	.8	.8	.2	-
Substrate type	boulder	boulder	boulder	boulder	boulder	boulder
Apparent stability	stable	stable	stable	-	stable	stable
Bank height (m)	<1	5	<1	10	<1	<1
Bank slope	gentle	gentle	gentle	40	gentle	gentle
Bank composition	rock	-	organic	morraine	organic	organic
Bank vegetation	spruce	alder	shrubs	alder	spruce	alder
Riparian cover	extensive	extensive	little	extensive	extensive	good
Habitat type	type 2&3	type 5	type 2&3	type 2	type 2	type 2
Salmonid abundance	rare	present	present	common	present	present
Sensitive areas	none noted	none noted	none noted	none noted	none noted	spawning area

Table 2. Continued

Km	138	144	157	179	186	194.5
Watercourse	unnamed	unnamed	unnamed	unnamed	unnamed	Valley R.
Maximum depth (cm)	-	86	40	98	150	38
Mean depth (cm)	100	42.8	27.6	55.4	40	21.5
Max velocity (m/s)	-	.93	.95	.25	-	.84
Mean velocity(m/s)	2.5	.56	.686	.24	1.1	.45
Width (m)	15	11	14	4.5	20	15
Discharge (m /s)	35	2.7	2.82	.59	8.8	1.21
Gradient (%)	3.5	-	.3	.1	2.6	1.8
Substrate type	boulder	boulder	boulder	cobble	boulder	boulder
Apparent stability	stable	stable	stable	stable	stable	stable
Bank height (m)	1	2	1	<1	3-5	5
Bank slope	gentle	45	gentle	gentle	moderate	moderate
Bank composition	bedrock	morraine	fluvial	organic	morraine	gravel
Bank vegetation	spruce	spruce	spruce	low shrubs	alder	alder
Riparian cover	extensive	extensive	minimal	nil	fair	minimal
Habitat type	type 3	type 2	type 4	type 4	type 3	type 3&4
Salmonid abundance	common	common	rare	nil	-	present
Sensitive areas	high velocity	none noted	none noted	none noted	none noted	none noted

Table 3. A summary of the physical and biological characteristics measured at selected sites along the alternate route of the Labrador tote road.

Km	86.5	103.5	121.5	125	130	147.5
Watercourse	Miron R.	Bernadette R	Evening R.	unnamed	Wide R.	unnamed
Maximum depth (cm)	100	78	36	100	92	55
Mean depth (cm)	60	39.9	12	-	55.4	36.2
Max velocity (m/s)	-	.94	.69	none	.24	.84
Mean velocity(m/s)	1.3	.496	.34	-	.155	.459
Width (m)	60	16	27	20	9	26
Discharge (m /s)	45	3.6	1.1	.1	.8	4.3
Gradient (%)	2	.4	.5	.1	<.1	1
Substrate type	boulder	boulder	cobble	organic	boulder	gravel
Apparent stability	fair	stable	stable	poor	stable	fair
Bank height (m)	10	<1	<1	<1	2-3	2
Bank slope	60	gentle	gentle	flat	gentle	moderate
Bank composition	gravel	morraine	organic	bog	organic	gravel
Bank vegetation	spruce	alder	spruce	grass	shrubs	alder
Riparian cover	nil	nil	nil	nil	nil	nil
Habitat type	type 3	type 2	type 2	type 4	type 4	type 1&2
Salmonid abundance	common	abundant	abundant	common	rare	present
Sensitive areas	none	none noted	spawning gravel	none noted	none noted	spawning habitat

4.0 FUTURE CONDITIONS

Impacts on fish resources resulting from the construction of the Labrador tote road can be divided into two distinct categories: short-term construction-related effects and long term effects which will become apparent up to several years after project completion. In both categories, most of the impacts are discussed in a general manner, then site-specific concerns are addressed for the preferred and alternate routes.

4.1 Construction Effects

The impacts discussed in this section would be the same for all three road scenarios (summer only, year-round and national connection), since present plans call for the same road standards and construction practices.

4.1.1 Siltation and Sedimentation

The deleterious effects of silt on fish and fish habitat have been well documented in the scientific literature (Cordone and Kelly 1961; Shapely and Bishop 1965; Hansen 1971; Ritchie 1972; Murphy et al. 1981). Direct fish mortality as a result of siltation is relatively rare and occurs only at very high sustained concentrations (i.e., >90 mg/L; Alabaster 1972). However, even at much lower concentrations decreased growth rate and body condition may result among fish exposed to sustained high turbidity (Alabaster 1972). Indirect effects of silt on fish through habitat degradation is a more common problem. When silt is introduced to a stream

it alters the hydraulic equilibrium of the watercourse and is transported or deposited according to prevailing physical conditions (Leopold 1968; Hansen 1971). The actual site of deposition is governed by depth and velocity of the stream, but as a general rule silt accumulates in pools during low discharges and in riffles during high discharges (Keller 1978).

The effects of sedimentation on fish habitat may greatly decrease the capacity of a watercourse to support fish. Silt accumulation in pools reduces the amount of habitat available for stream-resident fish when flows are low and deep habitat is especially critical. Silt accumulation in riffle areas at high flows may adversely affect survival of trout eggs, alevins and the aquatic invertebrates upon which the fish feed. Trout species select spawning areas where gravel permeability is high, most frequently at the head of a riffle (Stuart 1953; Webster 1981). An accumulation of silt or fine sand in these spawning areas will either prevent trout from attempting to spawn (Alabaster 1972) or, if spawning has already occurred, cause a much lower survival of eggs and fry through decreased intragravel flow (Hausle and Coble 1976; Webster 1981).

Fortunately, provided siltation occurs over a short period, natural fluviatile processes will tend to remove accumulated sediment from local areas of the watercourse and thereby minimize the impact. Some studies have demonstrated no measureable impact within a few months of severe siltation induced by stream crossing construction (Tsui and McCart 1981). The rate at which accumulated sediment is flushed from a watercourse will be totally dependent upon the size and hydrological characteristics of a given watercourse.

Within the context of the Labrador tote road, sediment may enter watercourses crossed by the right-of-way as a result of several

construction-related activities:

1. instream work -- rechanneling, culverting or bridging,
2. scour at river crossing resulting from channel constriction at culverts or bridges,
3. erosion as a result of clearing and grubbing operations prior to actual construction,
4. erosion along unstabilized ditches and side slopes subsequent to construction, and
5. run-off from borrow areas.

Sediment entering watercourses along the Labrador tote road from any of these sources could have severe short-term impact on fish habitat. Mitigative measures for each of these sources of siltation will be discussed in Chapter 6 of this report.

4.1.2 Gravel Removal

Alluvial deposits of gravel frequently provide convenient sources of aggregate materials suitable for road-surfacing operations. These same gravels provide critical spawning substrates for fishes, especially the highly valued salmonids. As a result, gravel removal from fish habitat is prohibited by the Canada Fisheries Act.

4.1.3 Construction Camps and Maintenance Depots

Construction camp facilities will be required to accommodate crews building the tote road. Camp facilities have been proposed at km 68, km 110 and km 174 on the proposed route. In addition, permanent maintenance depots

to store equipment necessary to maintain the road will be situated near km 138 and km 174. Construction camps on the alternate route will be located at km 68, km 138 and km 157, and permanent maintenance depots would be situated near km 110 and km 157. These facilities will likely generate a considerable amount of waste including garbage, human sewage, used oil, etc. All of these wastes have the potential to adversely affect fish habitat if they were to enter the surface run-off and discharge into a stream.

4.1.4 Fuels, Lubricants, and Chemicals

Construction of the tote road will require the storage of large quantities of fuel and lubricants. Waste lubricants will result from routine vehicle maintenance. In addition, a variety of chemicals including paints, preservatives, solvents and detergents will be required during the construction phase. Virtually all of these compounds are directly toxic to fish or other aquatic life.

4.1.5 Blasting

Blasting, which may be required at some river crossings to prepare bridge footings or remove large boulders, will likely kill any fish close to the site of the explosion. Furthermore, if blasting is not properly controlled it may result in slope destabilization and cause land or rock slides into watercourses. This can block fish migration through creation of a velocity barrier or it can introduce large quantities of silt and sand, the impact of which was discussed earlier (Section 4.1.1).

4.2 Long-Term Effects

Long term effects were defined as those impacts whose effects would be apparent more than one year after the completion of construction. As such, in absence of mitigation, this type of impact could be apparent at both 2 and 10 years after the completion of construction. Most of these impacts are independent of the three road scenarios, since they would be continuations of impacts resulting from the construction period.

The only aquatic impact that is likely to be dependent upon road scenario and operation is that of increased fish harvest as a result of improved accessibility. Our brief survey suggests that most watercourses crossed by the proposed tote road support relatively small populations of desirable sport fish (brook trout). However, it is uncertain whether any of the road scenarios would actually result in extensive exploitation of fish resources in any of these watercourses. The tourism component study has not projected any marked increase in tourist travel as a result of connection to the national highway system (D. Knight, pers. comm). Based upon personal observations elsewhere, it is considered to be most probable that sport fishery exploitation in any of the smaller rivers crossed is likely to be minor unless tourist facilities (e.g. a campground or picnic area) were established at the stream crossing. If these facilities were to be established, the brook trout population in the immediate area would likely be reduced within one to two years, since this species is relatively vulnerable to intensive angling pressure. In the longer term it is unknown whether brook trout populations would be able to respond to harvest by more successful recruitment or whether they would be displaced by less desirable

cohabitant species.

Sustained siltation is a potential source of long-term impact which is independent of road scenario. Unstabilized borrow sites, poorly designed stream crossings which are regularly damaged by flood waters, or erosion in ditches are the most likely causes of sustained siltation. Sustained siltation has the same short-term impacts as discussed earlier (Section 4.1.1) but since more fines are being added to the stream on a regular basis, there is no opportunity for the stream to flush out the silt and recover. As a result, much spawning habitat may be eliminated and sight predators such as brook trout may exhibit reduced growth rates and condition factors and may eventually be excluded from affected habitat.

The most severe of the long-term impacts is that of migration blockage by improperly installed stream crossings, usually culverts. When adequate culverts are installed correctly, they cause minimal habitat disruption. On the Island of Newfoundland, highway culverts have blocked access of anadromous salmon into many headwater streams and have probably reduced the total salmon production of many watercourses (pers. comm., R.J. Gibson, DFO). The relatively smooth inside surfaces of a culvert provide a much lower amount of friction relative to a natural streambed and as a result water velocities are much higher. The combination of high mean cross-sectional velocity plus the absence of rest areas renders many culverts impassable to fish. By contrast, in an undisturbed stream, friction and turbulence induced by boulder and cobble substrates result in much lower velocity near the streambed than that which occurs at mid-water. Moreover, water in streams tends to descend in a series of short steps (riffles) interspersed with pools which dissipate the kinetic energy accumulated in steep sections.

Stream-resident fish, especially the smaller individuals, rarely have to contend with the high surface velocities that occur in many streams; they normally remain near the bottom in the slower currents. Even small trout are capable of short bursts of considerable speed (approximately equal to 10 body lengths per second, Brett 1964). Small trout are able to move upstream against high velocities by swimming in short spurts and then resting in slow water areas among the substrate. The ability of trout to make headway against current is affected by water temperature and the size and condition of the individual fish. Since experimental data for brook trout are lacking, approximate maximum sustainable velocities (Table 1) have been extrapolated from rainbow trout (pers. comm., J. Kiceniuk, DFO) and Arctic char (Jones et al. 1974).

Table 1. The maximum velocity against which salmonids can move 100 m in 10 minutes (after Jones et al. 1974 and Kiceniuk, pers. comm.)

Fork Lengths (cm)	Velocity (cm/s)
10	30 to 36
20	48 to 60
30	65 to 78

Fish can swim through culverts 50 m and 25 m long in the same time period at velocities 8 cm/s and 12 cm/s higher than the above (Jones et al. 1974).

At present, there are few impassable barriers to fish migration in streams crossed by the Labrador tote road. If impassable culverts were installed, declines in available fish resources could result. Lakes adjacent to the road would also be subject to decreases in fish populations

which may use the watercourses to access critical spawning, rearing or overwintering habitat. This impact could conceivably result in the elimination of specific fish stocks within 10 years of project completion.

Potential environmental impacts on fish resources and fish habitat are similar along the preferred and alternate routes for the Labrador tote road. The principal difference between the two routes from a fish habitat perspective is that more previously undisturbed watercourses will be affected by the preferred route. However, provided adequate mitigation (Chapter 6) is applied, the only significant impacts which are anticipated along either route would be a possible decrease in game fish abundance as a result of exploitation.

4.3 Site-Specific Concerns

4.3.1 Proposed Route

Several specific crossings were identified as being more likely to result in significant impacts on aquatic resources. These sensitive areas are those where sport fish are very abundant, where high quality habitat is situated close to the crossing, or where migration obstruction is likely.

Km 70.5, unnamed river -- abundant brook trout; some potential spawning habitat downstream of centerline.

Km 77.5, unnamed river -- presently passable rapids at centerline; construction may create migration barrier.

Km 82.5, unnamed river -- abundant brook trout and potential spawning habitat near centerline, steep downstream.

Km 85.5, Miron River -- steep gradient and high discharge may already present a partial obstruction; any constriction of channel would form a complete obstruction.

Km 114.0, unnamed river -- steep gradient may cause migration obstruction in a culvert.

Km 116.5, unnamed river -- good trout habitat.

Km 126.5, unnamed river -- good trout habitat with some potential spawning habitat downstream.

Km 138.0, unnamed river -- steep gradient may create velocity barriers in culverts at present road location.

Km 144.0, unnamed river -- steep gradient may cause velocity barriers at present road location.

Km 186.0, unnamed river -- large river and steep gradient will likely cause a velocity barrier if channel constructed.

Km 194.5, Valley River -- two channels separated by island; both have high discharges and steep gradients which could create velocity barriers in crossing structures.

Km 160.5 and 162.0, Ossokmanuan Reservoir -- this site will likely be the most important sport fishing area along the preferred route. Constriction of the reservoir by the causeway will create current which will in turn attract fish.

4.3.2 Alternate Route

Specific crossings which are most likely to result in impact on aquatic resources along the alternate route are as follows:

Km 86.5, Miron River -- important fish habitat upstream; proposed bridge should minimize impact.

Km 103.5, Bernadette River -- abundant brook trout and good rearing habitat.

Km 121.5, Evening River -- good salmonid habitat near crossing.

Km 147.5, unnamed river -- excellent salmonid rearing and spawning habitat. An esker adjacent to the shoreline has been identified as a borrow site the use of which could result in chronic siltation of this watercourse.

5.0 SUMMARY OF FINDINGS AND COMPARISON OF ALTERNATIVES

5.1 Fish Resources

The fish fauna along both the proposed and alternate routes of the Labrador tote road are typical of the Labrador Plateau. The most widely distributed game fish are brook trout and northern pike. Lake trout, ouananiche and whitefish are restricted to the larger rivers and lakes along both routes. In addition to these important species, a variety of forage and so-called coarse fishes are present in all watercourses.

Brook trout sampled in all watercourses crossed by the proposed tote road are typical of the smaller form of brook trout present in some watersheds of Labrador (Wheeler 1977). It is unknown if any waterbodies along either route support populations of large brook trout (e.g., Bruce 1974). In absence of large brook trout, none of the sites sampled on either route are likely to become important sport fishing areas. However, it is likely that the Ossokmanuan Reservoir crossing (not sampled during this study) on the proposed route will develop a good sport fishery for lake trout, ouananiche, and northern pike. A similar sport fishery presently exists at the Gabbro and Lobstick control structures farther downstream.

Direct impacts on fish populations resulting from construction could occur as a result of spills of fuels or other toxic chemicals, blasting, or extreme siltation. However, the most likely direct effect of the project will be increased harvest of desirable species which may result in a decrease of these species near the tote road. The likelihood of these impacts is very similar for the proposed and alternate routes (since the

latter also crosses a reservoir (at Gabbro Structure) though that is outside the boundaries of the present study).

5.2 Fish Habitat

Most of the proposed stream crossings on both routes are located in Type 2, 3 or 4 habitat. Of these, the steep gradients of Type 3 habitat are most likely to result in the formation of migration barriers if crossing structures are inadequate. Relatively little sensitive spawning habitat is situated near crossings on either route, the principal exceptions being unnamed streams at km 70.5, km 82.5, and km 126.5 on the proposed route and Evening River (km 121.5) and unnamed river (km 147.5) on the alternate route.

Although several of the watercourses crossed by both the proposed and alternate routes are relatively steep, high energy streams, there are few natural permanent barriers to migrating fish. In some smaller rivers, beaver dams form partial obstructions but only one complete obstruction, a waterfall roughly 5 m high, was observed (near km 82.5). This was situated about 0.5 km downstream of the proposed route, below the outlet of a small lake, and would not affect fish movement near the proposed highway crossing.

Virtually all of the potential impacts (from inadequate stream crossing structures, improperly installed culverts, sedimentation, gravel removal, blasting, wastes and spills) affect both the proposed and alternate routes equally. Neither of these routes is judged to be more sensitive than the other from the perspective of possible impact on aquatic resources.

6.0 MITIGATION AND MONITORING

6.1 Mitigative Measures

The following mitigative measures have been prepared in accordance with a variety of habitat protection guidelines prepared for roads and similar developments in Newfoundland and other areas. Publications examined include the following: Metsker (1970), Thronson (1971), Dryden and Stein (1975), Lauman (1976), Case and Rowe (1978), Dane (1978), Fisheries and Marine Service (1978), Toews and Brownlee (1981), Fisheries and Oceans and LGL Limited (1983), and McCubbin et al. (in prep.).

6.1.1 Buffer Zones

Whenever possible, a buffer zone of undisturbed vegetation should be left between the road right-of-way and any waterbody. The buffer zone will tend to filter sediment from run-off water and minimize impact. The recommended buffer zone width is 12 m plus 1.5 times the slope gradient (%). For example a 5% slope towards a waterbody should leave a buffer zone of no less than 19.5 m.

6.1.2 Stream Crossings

Location of Crossing

Stream crossings should be located such that:

1. there are no sudden increases in water velocity at the site or immediately up or downstream (see Section 6.2),
2. the channel gradient should be as near zero as possible, and
3. the stream is relatively straight.

Type of Crossing

Structures recommended for stream crossings are listed below in order of preference from a fish passage perspective:

1. bridges,
2. structural plate arch (bottomless),
3. structural plate pipe arch or flattened elliptical culvert,
4. cylindrical corrugated metal pipe (CMP's).

The above crossings are ranked in decreasing order of ease in maintaining fish passage criteria. When streambed slopes at the crossing site are less than 0.5%, CMP's of adequate size to prevent serious channel constriction are usually adequate to permit fish passage. Whenever cylindrical or elliptical culverts with closed bottoms are used, they should be installed such that the culvert bottom is below the natural streambed: as a general rule, 1/3 the diameter of the culvert for small culverts (less than 0.75 m diameter) should be buried. This placement will tend to permit deposition of stream gravels within the culvert and provide a more natural

substrate for fish passage. Furthermore, culverts should be placed such that a minimum depth of 15 cm of water is maintained within the culvert.

As a general rule, all stream crossings should be "overdesigned" to aid in maintenance of fish habitat. A design to carry 1 in 50 year floods was recommended by Fisheries and Oceans and LGL Limited (1983), whereas Dane (1978) recommended culvert capacity for 1 in 100 year run-off. In either case, the crossing structure should pass the expected yearly peak flow without creating significant upstream ponding or average velocities which will exceed 1.2 m/s for more than three consecutive days in an average year.

When culverts are used, ideally the culvert should be placed parallel with the streambed to prevent "jumps" at the downstream end. If streambed slopes are greater than 0.5%, and the stream is too small to justify bridge construction, a structural plate arch culvert is recommended to facilitate fish passage. In some instances where a bottomless archplate is not feasible, tailwater control structures or interior baffles (Dane (1978); Fisheries and Oceans and LGL Limited (1983)) may be used to improve fish passage within the culvert. Both of these latter methods require regular maintenance which will add to road maintenance costs. Therefore, other ameliorative measures should be sought such as route relocations to a lower gradient area. When multiple culvert crossings are employed, only one must be designed to meet fish passage criteria.

Timing of Crossing

Instream activities, such as culvert and bridge piling construction, are restricted by Department of Fisheries and Oceans during the period when fish spawning and incubating eggs might be affected. In Labrador, the

allowable time for instream work is June 15 to September 1. It is possible that this restriction may be waived for several of the stream crossings where little or no good fish habitat was identified.

Siltation Control

To minimize siltation of downstream fish habitat the following mitigations are recommended:

1. Delay grubbing of a 30 m buffer zone until actual start of crossing construction.
2. Use backhoe from shore in preference to a bulldozer in the stream to perform any necessary channel modification.
3. Divert streamflow around actual site of instream activity using sandbag coffer dams.
4. Stabilize disturbed streambanks or cuts and fills adjacent to watercourses with riprap or suitable alternative as soon as possible to prevent erosion of fines.

Blasting

Blasting, where necessary at stream crossings, must be conducted when no migrating fish are in the area. This can only be determined on a site-specific basis through co-ordination with DFO. During field investigations (late July) no major migrations were in evidence.

6.1.3 Deleterious Substances

All substances used during road construction that are toxic or otherwise harmful to aquatic life should be stored, used or disposed of in an appropriate manner.

Fuels and lubricants should be stored in a manner consistent with Department of Environment standards in suitable containers, surrounded by impermeable berms which would contain spills. These fuel depots should not be situated within 100 m of any waterbody. Similarly, refueling of equipment and routine maintenance should not be conducted within 100 m of any watercourse.

Other toxic substances such as cement, lime, grout, solvents, paints, etc. should not be stored within 100 m of any waterbody. When these substances are used care must be exercised to prevent accidental spillage into any waterbody.

Disposal of all wastes including used crank case oil, empty containers, camp garbage, etc., should be conducted in a manner and at a site approved by Department of Environment. Disposal sites should be more than 100 m from the nearest waterbody and run-off from the disposal site should not flow into a watercourse.

Human sewage should receive at least primary treatment in a septic tank. Effluent from the septic system must not be allowed to discharge directly into any waterbody.

All equipment operating near waterbodies should be free of oil, fuel, or hydraulic fluid leaks.

6.1.4 Sedimentation From Erosion

All borrow areas should be no less than 100 m away from the nearest watercourse. Run-off from all borrow areas should be directed away from fish habitat and excess sediment removed either in a settling basin or by directing run-off into bog land.

Erosion in ditches and side grades which could introduce silt into fish habitat should be prevented by use of organic mulches, anti-erosion mats, check dams, or similar measures. Run-off from roadways should be diverted into bogs rather than streams whenever possible. The proposed construction plan of close cutting and filling instead of extensive grubbing should act to minimize sedimentation in those areas where cuts are not required to maintain acceptable slope.

6.1.5 Increased Harvest

Impact resulting from increased sport fishing as a result of the highway development can only be mitigated by adequate management and enforcement. The large area made accessible as a result of either the preferred or alternative routes will result in a significant increase in the work load of D.F.O. Resource Management Branch staff. This problem is the sole responsibility of D.F.O. and will be addressed when necessary (D. Clarke, D.F.O., Goose Bay, pers. comm.).

6.2 Site-Specific Mitigations (proposed route)

The crossing structures recommended to ensure adequate fish passage at each of the crossing locations examined during the field program are listed in Table 4. In some cases different crossing structures would be possible or required if the road centerline were moved a short distance up or downstream.

The crossing structures recommended in the report are based upon field flow measurements and an initial assessment of runoff coupled with an assessment of potential for important seasonal fish migration. In absence of detailed design calculations, structures which exceed minimum guideline standards have been recommended when significant fish migration was considered to be probable. It is conceivable that more detailed analysis during design studies will prove that alternate structures may be acceptable in these cases.

Several sites were identified to have sensitive fish habitat in the vicinity of the tote road crossing which could be vulnerable to sedimentation. Of these, only two, Miron River (km 85.5) and unnamed river (km 116.5) were also considered to have banks which would be likely to be highly susceptible to erosion. In both of these areas river banks are steep and are composed of erodible morrainal deposits. During construction in both of these areas, excessive sedimentation could be prevented through use of filter fabrics which would remove sediment particles from any runoff occurring between the time of actual construction and final slope stabilization. In these locations extra priority should be given to

Table 4. Recommended crossing structures for some selected watercourse crossings along the preferred route. For purpose of brevity in this table, the following abbreviations have been used: Arch plate = structural plate arch, Pipe arch = structural plate pipe arch, Culvert = cylindrical or elliptical culvert sunk into streambed.

Stream and km.	Recommended structure	Comments
Km 70.5, unnamed	Arch plate or pipe arches.	Brook trout habitat up and downstream, likely to be spawning migration in this area.
Km 72.0, unnamed	Culvert.	Low fish density in area but probable migration route from pond downstream. Existing beaver dams may obstruct fish migration at some flows.
Km 77.5, unnamed	Arch plate or pipe arches.	Rapids at centerline may create a barrier when stream culverted. Consider moving crossing 30 to 50 m upstream.
Km 82.5, unnamed	Arch plate or pipe arches.	Important salmonid habitat near proposed crossing; also probable migration route.
Km 85.5, Miron R.	Bridge.	Probable fish migration route; steep gradient at the crossing would create a velocity barrier if the stream were constricted.
Km 88.5, unnamed	Culverts.	Probable fish migration at crossing.
Km 102.1, unnamed	Arch plate or pipe arches.	Probable migration route; not examined in detail during field study.
Km 103.0, unnamed	Culvert.	No major fish movements anticipated.
Km 111.5, unnamed	Culvert.	Poor fish habitat; no significant migration likely.
Km 114.0, unnamed	Arch plate or bridge.	Fish migration likely; gradient could obstruct fish movement through culverts.
Km 116.5, unnamed	Arch plate.	Brook trout relatively abundant; high velocities observed; possible obstruction if stream constricted.

Table 4 continued.

Stream and km.	Recommended structure	Comments
Km 122.0, unnamed	Pipe arches or culverts.	Gradient is gentle and velocities are low; migration obstruction unlikely provided sufficient culverts provided.
Km 126.5, unnamed	Arch plates or pipe arches.	Significant fish movement likely but gradient should not cause obstruction provided stream not severely constricted.
Km 138.0, unnamed	Bridge,	Probable fish migration route; steep gradient and high discharge would render fish passage through culverts impossible; large culvert crossing possible if road moved 500 m upstream to Type 4 habitat.
Km 144.0, unnamed	Arch plate or pipe arches.	Small rapids situated at crossing; recommend moving crossing 50 m downstream; if moved, large culverts could be sufficient.
Km 157.0, unnamed	Pipe arch or culverts.	Flooded by reservoir.
Km 179.0, unnamed	Culvert.	Will require channel modification to consolidate flow through bog area; gradient is low, so large sunken culvert should not obstruct fish.
Km 186.0, unnamed	Bridge or arch plate.	If crossing situated in narrows, steep gradient would produce a velocity barrier inside a culvert; if road relocated to cross pool area, large culverts or arch plates may be sufficient.
Km 194.5, Valley R.	Bridges or arch plate.	Two river channels; each requiring a bridge due to steep gradients at present location; if crossing moved, arch plates may be sufficient.

minimize the amount of time between ground surface disruption and final stabilization of cuts leading to the stream crossings.

6.3 Site-Specific Mitigations (alternate route)

Since the watercourses crossed by the alternate route are larger, fewer of them are suitable for culvert crossing and will require larger structures (Table 5).

Of the three sites identified to have critical fish habitat near the tote road crossing, only one unnamed river (km 147.5) was judged to be highly susceptible to the effects of sedimentation due to the presence of a moderate bank slope and highly erodible esker deposits. This vulnerability is further complicated by the identification of the nearby esker as a possible source of borrow material. To prevent severe sedimentation of potential spawning habitat in this area, it is recommended that, if possible, alternate sources of borrow material be utilized. If alternate sources are not available, a settling basin should be constructed to remove excess sediment from the borrow area runoff. The bank slopes approaching the river crossing are also vulnerable to erosion; excess sediment could be removed from runoff from these slopes through use of check dams and/or filter fabrics until such time as construction is completed and the river approach is stabilized.

Table 5. Recommended crossing structures for some selected watercourse crossings along the alternate route.

Watercourse	Recommended structure	Comments
Km 86.5, Miron R.	Bridge.	Fair to poor habitat at crossing but migration likely; wide river and high flow would render fish passage impossible if channel constricted.
Km 103.5, Bernadette R.	Bridge preferred but several arch plates may be acceptable.	Good fish habitat; railroad crossing downstream consists of culverts, which probably restrict fish passage at high flow.
Km 120.5, unnamed	Bridge or arch plates.	Apparently good fish habitat and probable migration route; not studied.
Km 121.5, Evening R.	Bridge or arch plates.	Good fish habitat and probably an important migration route between Evening Lake and Boot Lake.
Km 125.0, unnamed	Culvert.	Poor salmonid habitat and low gradient; cylindrical culvert acceptable.
Km 130.0, Wide R.	Culvert.	Low gradient should permit fish passage through culvert.
Km 147.5, unnamed	Bridge recommended.	Gravel substrate and banks provide excellent fish habitat which would likely scour if flow is constricted.

6.4 Suggested Monitoring Program

6.4.1 Finalizing Crossing Sites

In order to minimize the need for costly remedial measures it is recommended that the road centerline be moved in several instances to cross watercourses where the slope is minimal. This could best be accomplished by joint reconnaissance by engineering personnel and those familiar with fish passage criteria.

6.4.2 During Construction

It is recommended that a designated environmental monitor be on site for the duration of the construction period. This individual would ensure that the road contractors are employing acceptable means to minimize siltation of downstream fish habitat during culvert installations, stabilizing disturbed areas to minimize erosion, controlling run-off from borrow sites, and following all other environmental regulations. Another important part of the monitor's duties would be to inspect all culverts to ensure that they meet fish passage criteria.

6.4.3 Subsequent to Construction

One year after construction all stream crossings should be inspected to ensure that they meet fish passage guidelines. Ideally this inspection should occur when fish migrations are expected. If fish concentrations are

apparent downstream of any crossing, some remedial actions may be necessary. During this inspection, all borrow sites and abandoned camps, etc. should be checked to ensure they have been stabilized to prevent erosion of sediment into fish habitat. Subsequently, annual inspections should be conducted to ensure that all fish passage facilities continue to function adequately.

7.0 LITERATURE CITED

Alabaster, J.S. 1972. Suspended solids and fisheries. Proc. R. Soc. Lond. 180:395-406.

Brett, J.R. 1964. The respiratory metabolism and swimming performance of young sockeye salmon. J. Fish. Res. Board Can. 21:1183-1226.

Bruce, W.J. 1974. The limnology and fish population of Jacopie Lake, West Forebay, Smallwood Reservoir, Labrador. Can. Dept. Envir. Fish. Mar. Serv. Tech. Rep. Ser. NEW/T-74-2. 74 p.

Bruce, W.J. 1975. Experimental gillnet fishing at Lobstick and Sandgirt lakes, Smallwood Reservoir, Western Labrador, 1974. Can. Dept. Envir. Fish. Mar. Serv. Int. Rep. Ser. NEW/1-75-3. 35 p.

Bruce, W.J. 1984. Potential yield from Smallwood Reservoir, Western Labrador, with special emphasis on lake whitefish. N. Amer. J. Fish. Manage. 4:48-66.

Bruce, W.J., and R.F. Parsons. 1976. Biology of the fishes of Ossokmanuan Reservoir, Labrador, 1976. Fish. Mar. Serv. Tech. Rep. 836: iv + 33 p.

Bruce, W.J. and K.D. Spencer. 1979. Mercury levels in Labrador fish, 1977-78. Can. Industry Rep. Fish Aquat. Sci. 111. 12 p.

Case, A.B., and D.A. Rowe. 1978. Environmental guidelines for resource road construction. Fish. and Envir. Can. Inform. Rep. N-X-162. 41 p.

Cordone, A.J., and D.W. Kelley. 1961. The influence of inorganic sediment on the aquatic life of streams. Calif. Fish and Game 47:189-228.

Dane, B.G. 1978. Culvert guidelines: recommendations for the design and installation of culverts in British Columbia to avoid conflict with anadromous fish. Fish. Mar. Serv. Tech. Rep. No. 811. 57 p.

Department of Fisheries and Oceans and LGL Limited. 1983. Urban development: guidelines for the protection of fish habitat in insular Newfoundland. Government of Canada, Fisheries and Oceans, St. John's, NF. 95 p.

Dryden, D.L., and J.N. Stein. 1975. Guidelines for the protection of fish resources of the Northwest Territories during highway construction and operation. Dept. Fish. Mar. Serv., Tech. Rep. Series No. CEN/T-71-1. 32 p.

Fisheries and Marine Service. 1978. Guidelines for land development and protection of the aquatic environment. Fish. Mar. Serv. Tech. Rep. No. 807. 55 p.

Hansen, E.A. 1971. Sediment in a Michigan trout stream, its source, movement and some effects on fish habitat. U.S.D.A. Forest Serv. Res. Pap. N.C. 59. 14 p.

Hausle, D.A., and D.W. Coble. 1976. Influence of sand in redds on survival and emergence of brook trout (Salvelinus fontinalis). Trans. Am. Fish. Soc. 105:57-63.

Jones, D.R., J.W. Kiceniuk, and O.S. Bamford. 1974. Evaluation of the swimming performance of several fish species from the Mackenzie River. J. Fish. Res. Board Can. 31:1641-1647.

Jones, J.B. 1976. Development strategy for Labrador's native population: the case of commercial fishing. Envir. Can., Fish. Mar. Serv. Also M.A. Thesis, University of Alberta, Department of Economics. 93 p.

Jones, M.L., G.L. Cunningham, D.R. Marmorek, P.M. Stokes, C. Wren, and D. deGraaf. 1986. Mercury release in hydroelectric reservoirs. Unpubl. Rep. to Canadian Electrical Association, CEA No. 185 G 399.

Keller, E.A. 1978. Pools, riffles and channelization. Envir. Geol. 2:119-127.

Lauman, J.E. 1976. Salmonid passage at stream-road crossings: a report with department standards for passage of salmonids. Unpubl. report. Environmental Management Section, Dept. of Fish and Wildlife, Portland, Oregon. 78 p.

Leopold, L.B. 1968. Hydrology for urban land planning--a guidebook on the hydrologic effects of urban land use. U.S. Dept. Interior, Geological Survey Circular 554. 18 p.

McCubbin, R.N., A.B. Case and D.A. Rowe. In Prep. Environmental guidelines and design criteria for resource road construction. Fisheries and Oceans and Canadian Forestry Service, St. John's, NF.

Metsker, H.E. 1970. Fish versus culverts: some considerations for resource managers. U.S.D.A. Forest Service. Engineering Technical Report ETR-7700-5. 19 p.

Murphy, M.L., C.P. Hawkins, and N.H. Anderson. 1981. Effects of canopy modification and accumulated sediment on stream communities. Trans. Am. Fish. Soc. 110:469-78.

Ritchie, J.C. 1972. Sediment, fish and fish habitat. J. Soil and Water Conserv. 27:124-125.

Scott, W.B., and E.J. Crossman. 1973. Freshwater fishes of Canada. Fish. Res. Board Can. Bull. 184. 966 p.

Shapely, S.P., and D.M. Bishop. 1965. Sedimentation in a salmon stream. J. Fish. Res. Board Can. 22:919-928.

Stuart, T.A. 1953. Water currents through permeable gravels and their significance to spawning salmonids, etc. Nature 172:407-408.

Toews, D.A.A., and M.J. Brownlee. 1981. A handbook for fish habitat protection on forest lands in British Columbia. Land Use Unit, Habitat Protection Division, Dept. Fisheries and Oceans, Vancouver, B.C. 166 p.

Thronson, R.E. 1971. Control of sediments resulting from highway construction and land development. U.S. Environ. Prot. Agency Report PB-228027. 50 p.

Tsui, P.T.P., and P.J. McCart. 1981. Effects of stream crossing by a pipeline on the benthic macroinvertebrate communities of a small mountain stream. Hydrobiologia 79:271-276.

Webster, D.A. 1981. Spawning. Trout 22(4):6-13.

Wheeler, J.P. 1977. Aspects of the biology of the brook trout, Salvelinus fontinalis (Mitchell) 1815, in the Valley River, Labrador. Fish. Mar. Serv. Manuscript. Rep. 1425. 19 p.

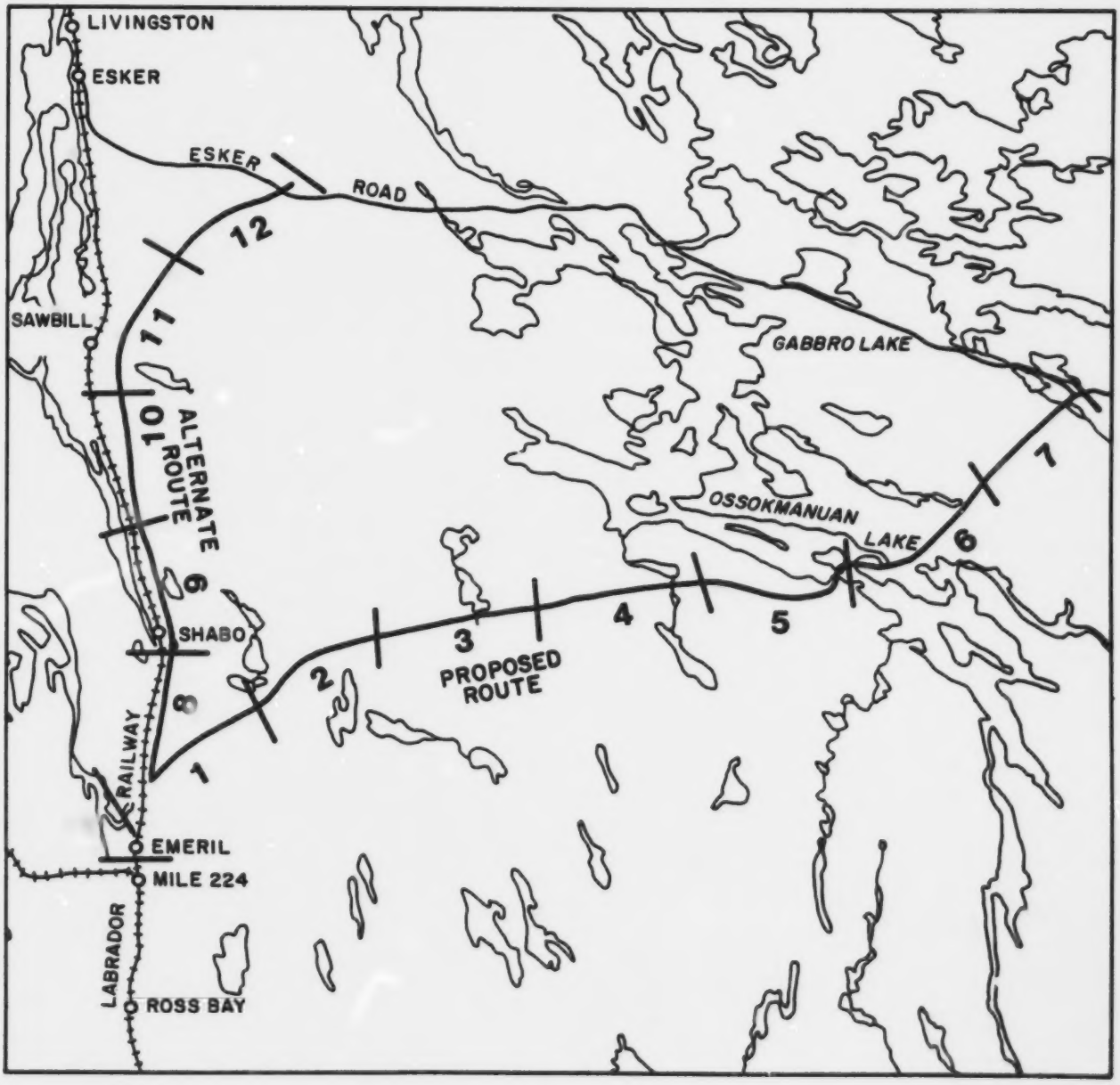
APPENDICES

ROSS BAY JCT. TO CHURCHILL FALLS
PROPOSED TOTE ROAD

LGL LTD.
FISH HABITAT SURVEY

APPENDIX 1

KEY MAP



LGL LTD.

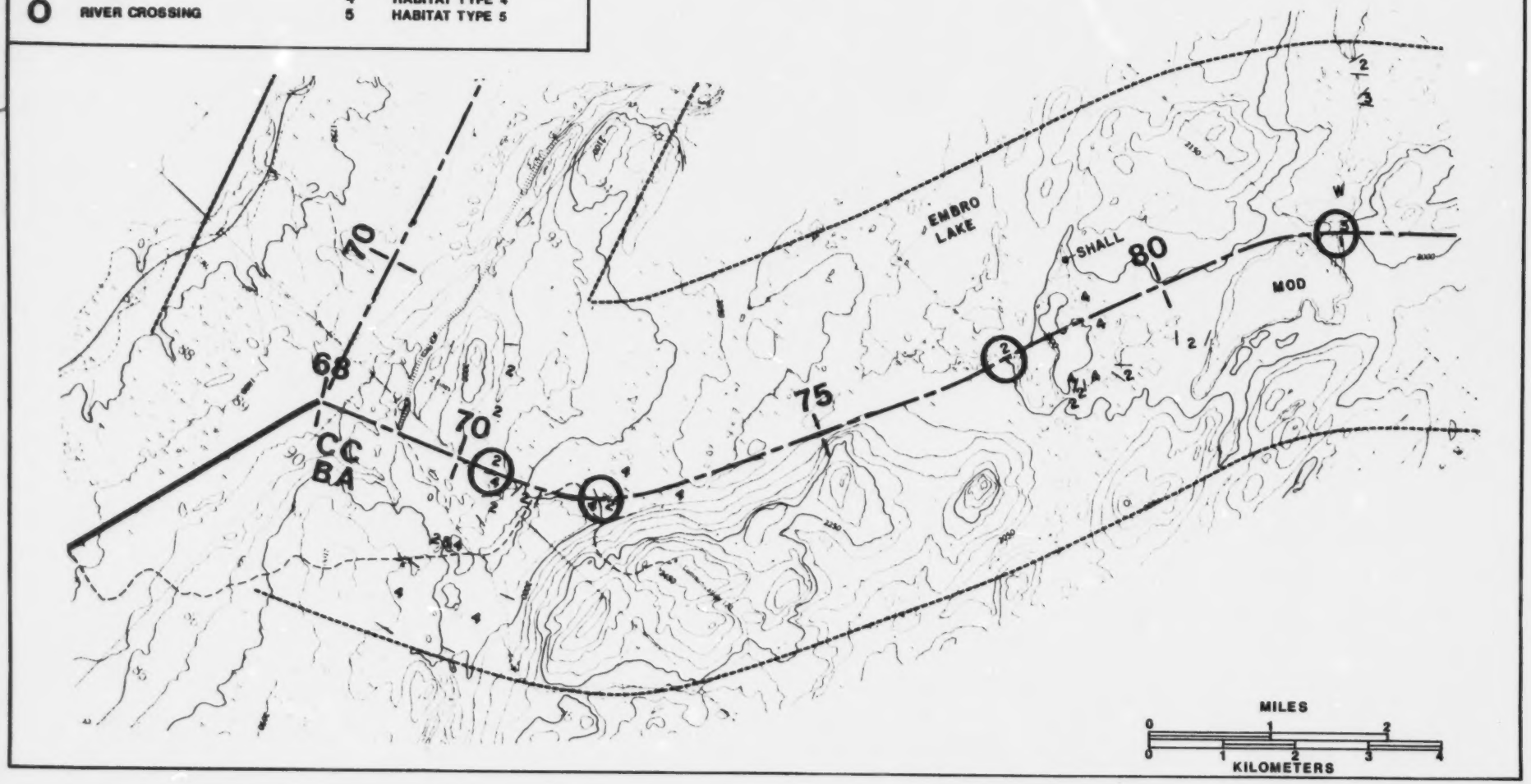
FISH HABITAT SURVEY LEGEND

CC	CONSTRUCTION CAMP
BA	BORROW AREA
MD	MAINTENANCE DEPOT
B	BRIDGE
O	RIVER CROSSING

W	WATERFALL
BD	BEAVER DAM
SHALL	SHALLOW LAKE
MOD	MODERATE DEPTH LAKE
1	HABITAT TYPE 1
2	HABITAT TYPE 2
3	HABITAT TYPE 3
4	HABITAT TYPE 4
5	HABITAT TYPE 5

SHEET No. 1

PROPOSED ROUTE



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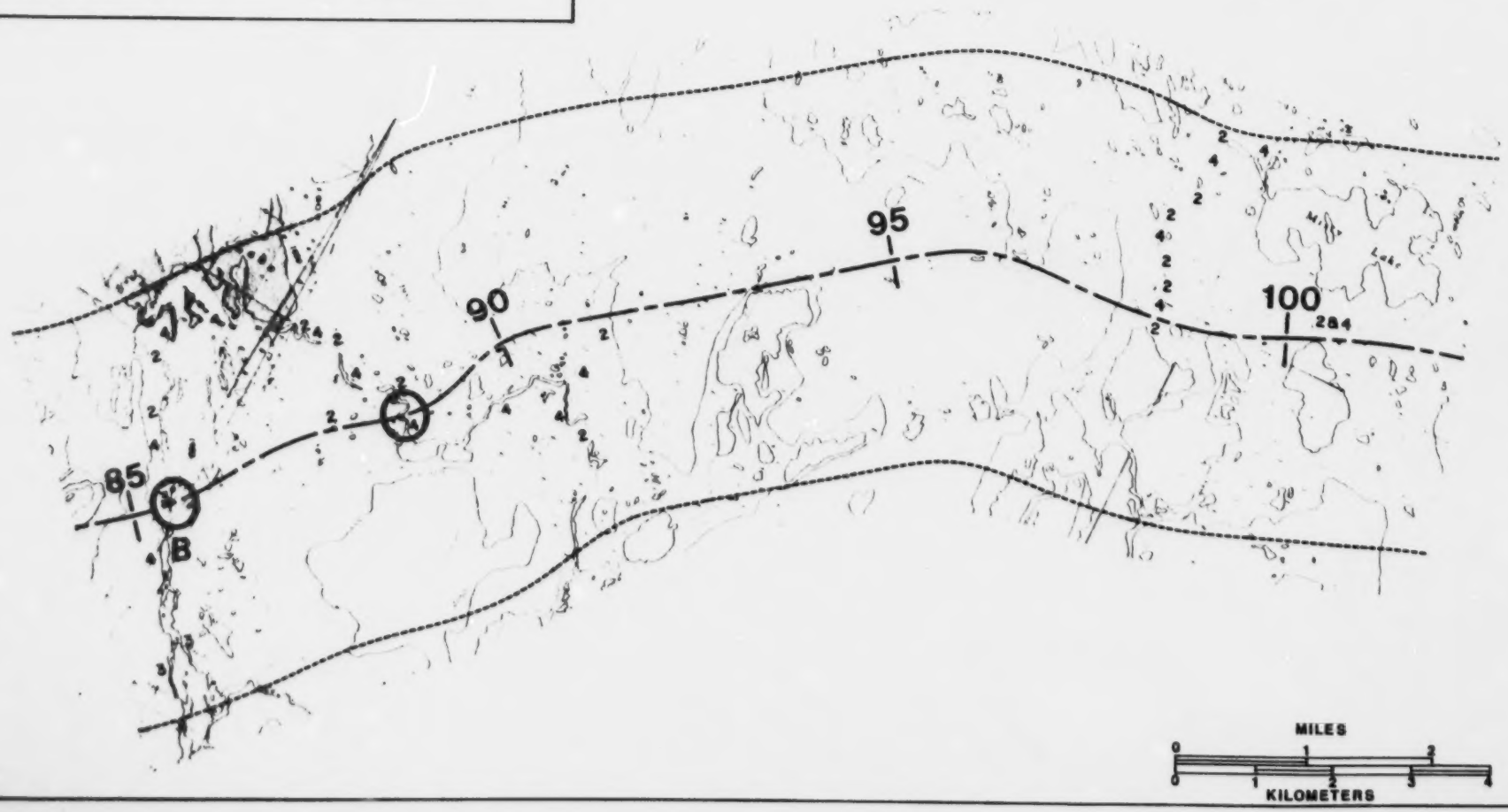
FISH HABITAT SURVEY

LEGEND

CC	CONSTRUCTION CAMP	W	WATERFALL
BA	BORROW AREA	BD	BEAVER DAM
MD	MAINTENANCE DEPOT	SHALL	SHALLOW LAKE
B	BRIDGE	MOD	MODERATE DEPTH LAKE
O	RIVER CROSSING	1	HABITAT TYPE 1
		2	HABITAT TYPE 2
		3	HABITAT TYPE 3
		4	HABITAT TYPE 4
		5	HABITAT TYPE 5

SHEET No. 2

PROPOSED ROUTE



LGL LTD.

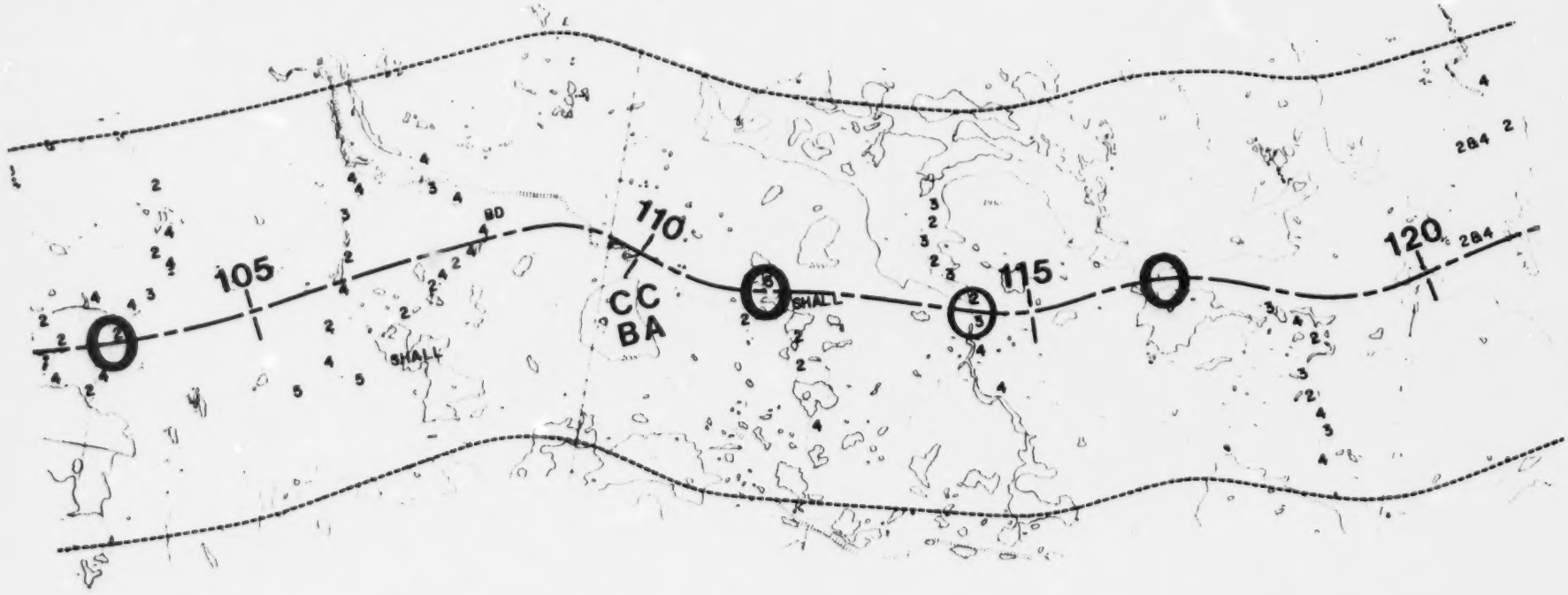
FISH HABITAT SURVEY LEGEND

CC	CONSTRUCTION CAMP
BA	BORROW AREA
MD	MAINTENANCE DEPOT
B	BRIDGE
O	RIVER CROSSING

W	WATERFALL
BD	BEAVER DAM
SHALL	SHALLOW LAKE
MOD	MODERATE DEPTH LAKE
1	HABITAT TYPE 1
2	HABITAT TYPE 2
3	HABITAT TYPE 3
4	HABITAT TYPE 4
5	HABITAT TYPE 5

SHEET No. 3

PROPOSED ROUTE



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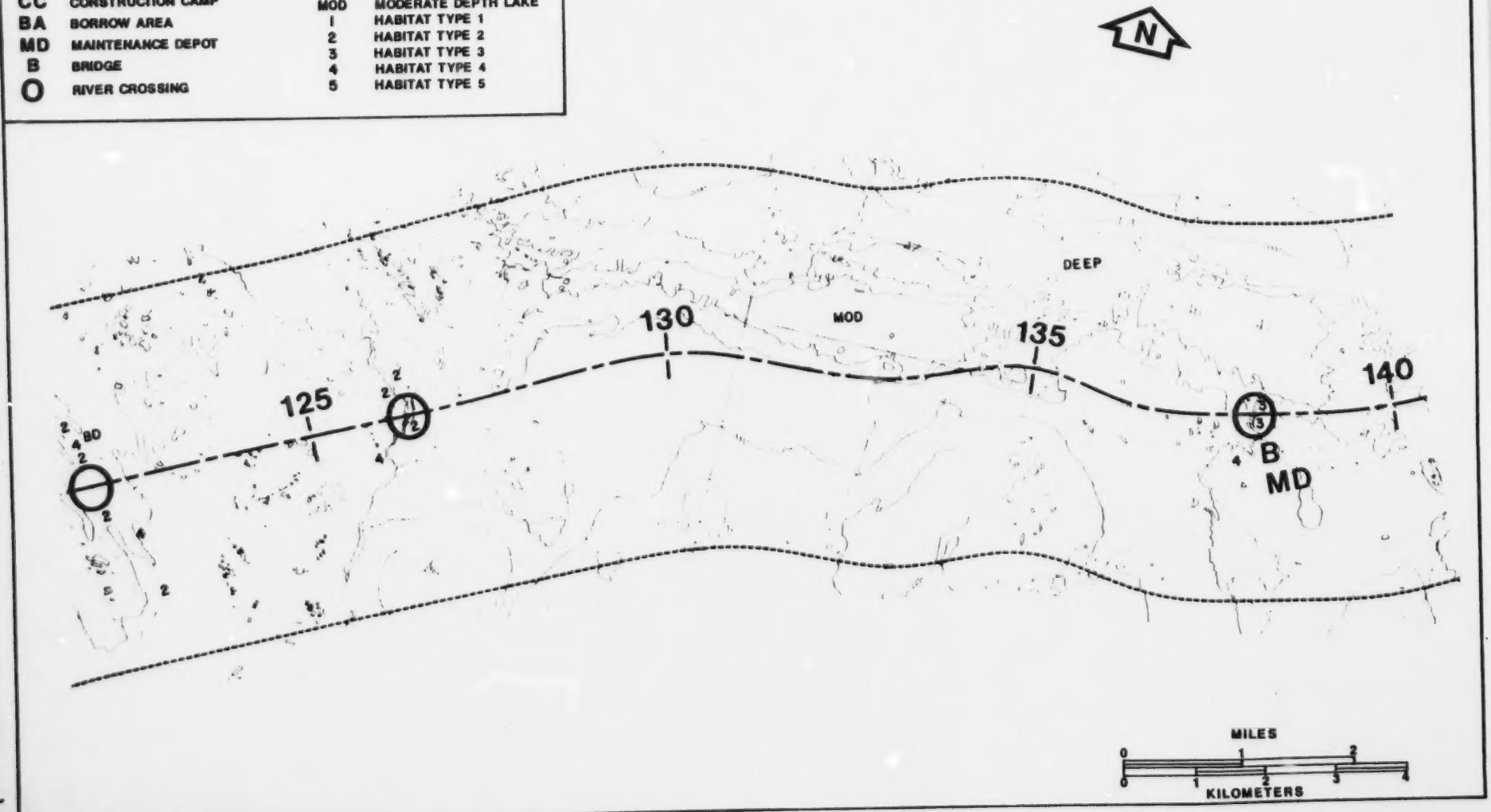
FISH HABITAT SURVEY
LEGEND

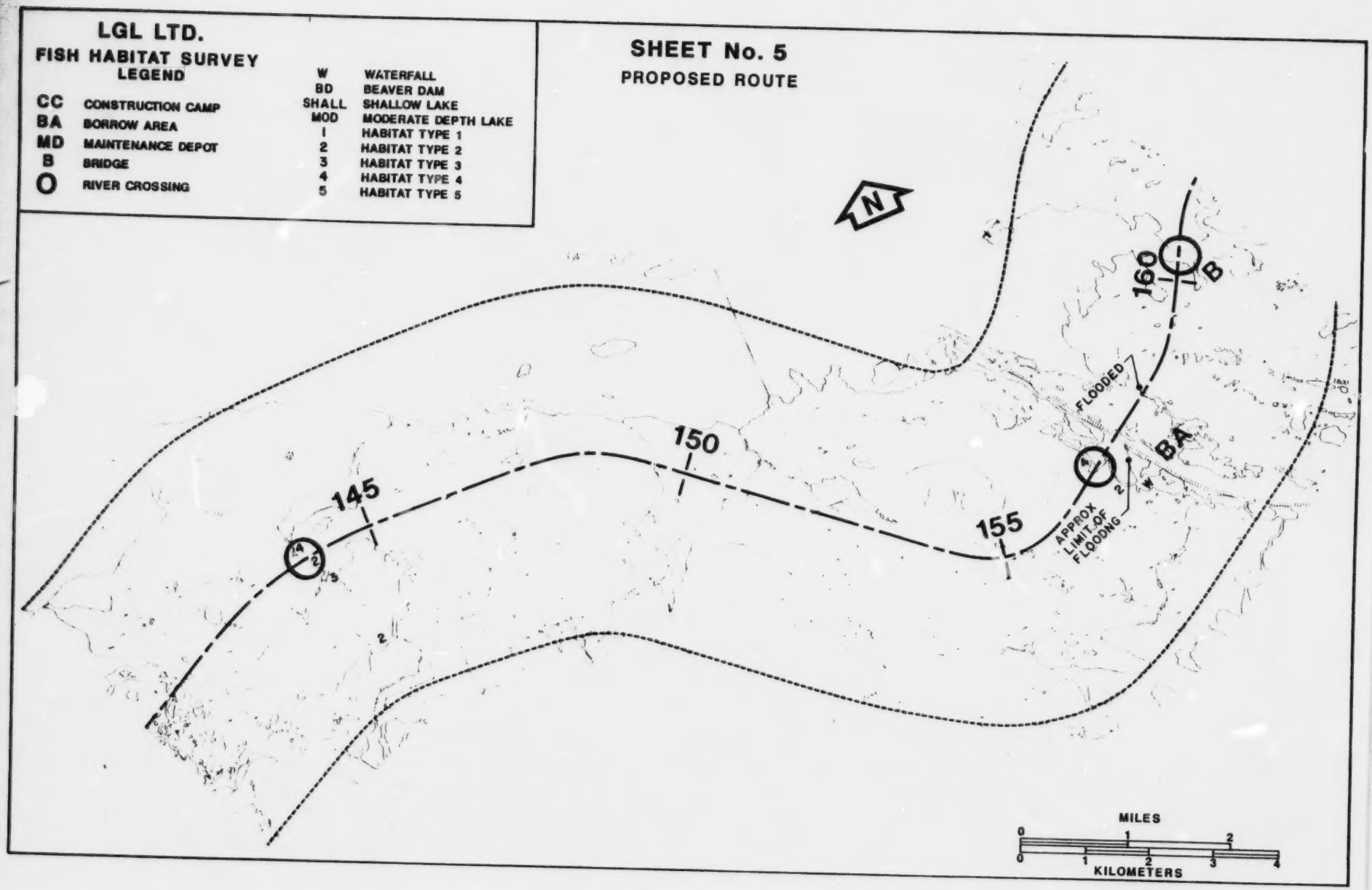
CC	CONSTRUCTION CAMP
BA	BORROW AREA
MD	MAINTENANCE DEPOT
B	BRIDGE
O	RIVER CROSSING

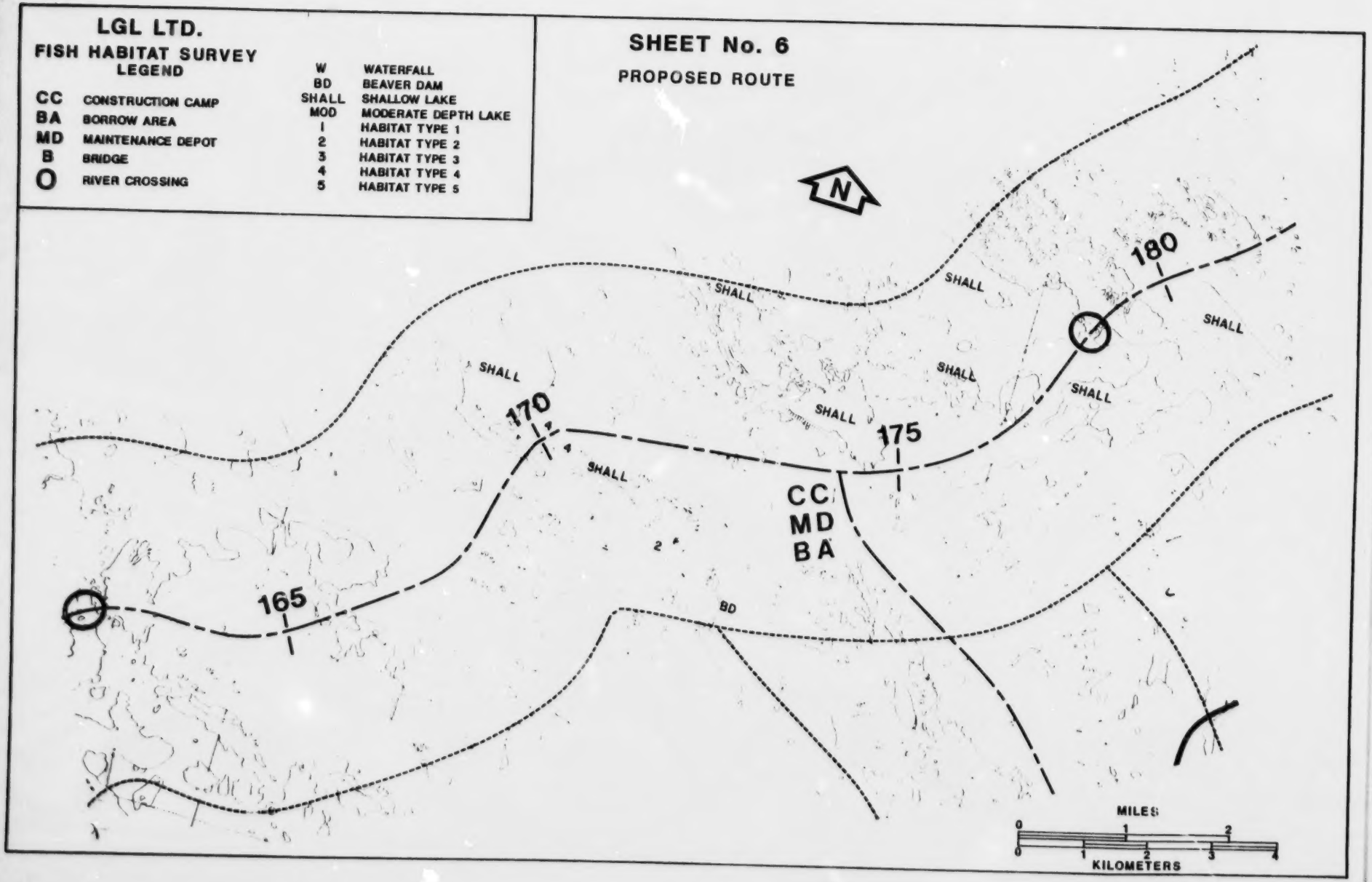
W	WATERFALL
BD	BEAVER DAM
SHALL	SHALLOW LAKE
MOD	MODERATE DEPTH LAKE
1	HABITAT TYPE 1
2	HABITAT TYPE 2
3	HABITAT TYPE 3
4	HABITAT TYPE 4
5	HABITAT TYPE 5

SHEET No. 4

PROPOSED ROUTE




LGL LTD.
FISH HABITAT SURVEY
LEGEND
CC CONSTRUCTION CAMP
BA BORROW AREA
MD MAINTENANCE DEPOT
B BRIDGE
O RIVER CROSSING
W WATERFALL
BD BEAVER DAM
SHALL SHALLOW LAKE
MOD MODERATE DEPTH LAKE
1 HABITAT TYPE 1
2 HABITAT TYPE 2
3 HABITAT TYPE 3
4 HABITAT TYPE 4
5 HABITAT TYPE 5
SHEET No. 5
PROPOSED ROUTE
N
145
150
155
160
B
BA
FLOODED
APPROX LIMIT OF FLOODNG
MILES
KILOMETERS


LGL LTD.
FISH HABITAT SURVEY
LEGEND
CC CONSTRUCTION CAMP
BA BORROW AREA
MD MAINTENANCE DEPOT
B BRIDGE
O RIVER CROSSING
W WATERFALL
BD BEAVER DAM
SHALL SHALLOW LAKE
MOD MODERATE DEPTH LAKE
1 HABITAT TYPE 1
2 HABITAT TYPE 2
3 HABITAT TYPE 3
4 HABITAT TYPE 4
5 HABITAT TYPE 5
SHEET No. 6
PROPOSED ROUTE
N
165
170
175
180
CC
MD
BA
BD
SHALL
MILES
KILOMETERS

LGL LTD.

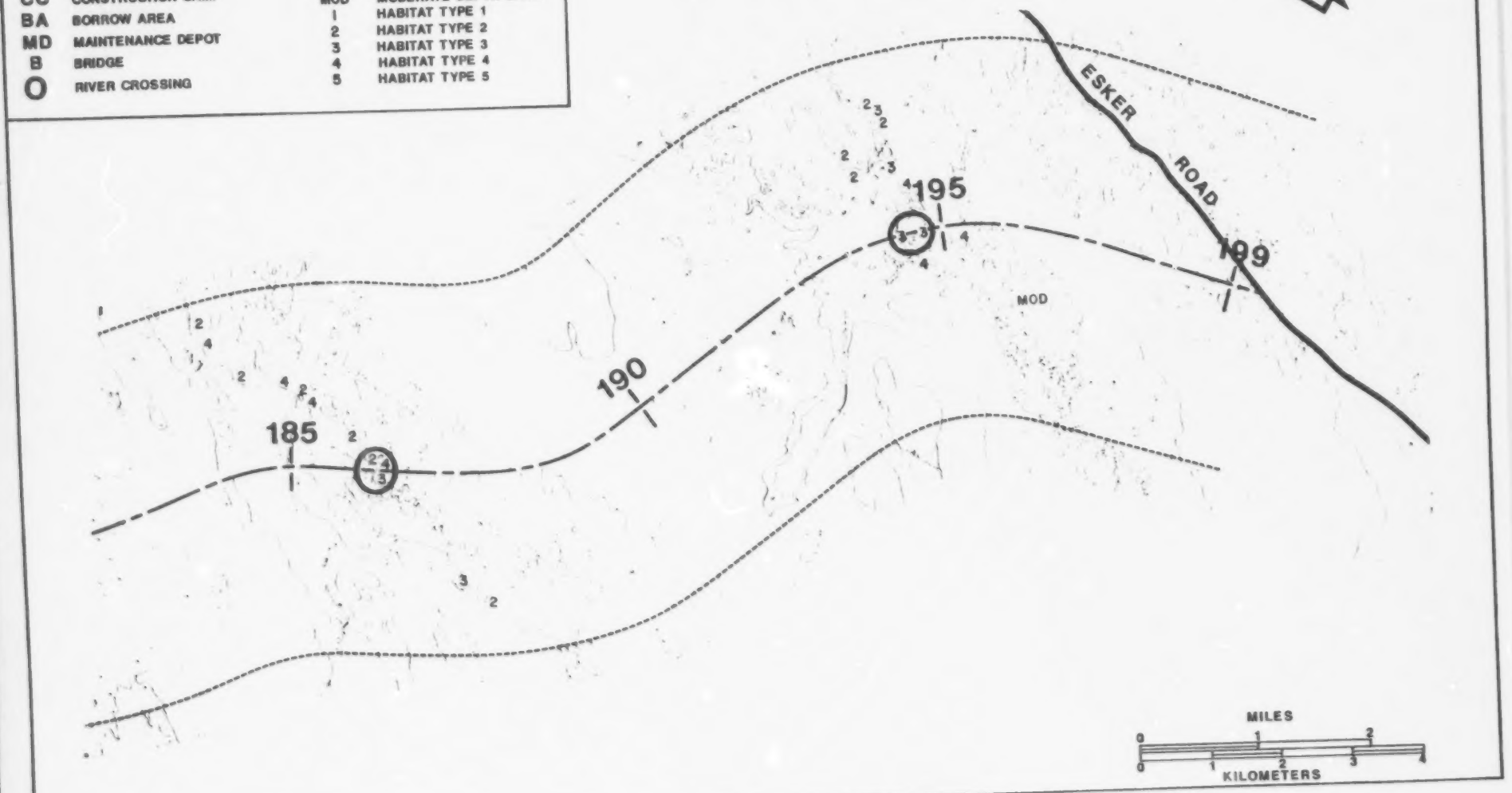
FISH HABITAT SURVEY
LEGEND

CC	CONSTRUCTION CAMP
BA	BORROW AREA
MD	MAINTENANCE DEPOT
B	BRIDGE
O	RIVER CROSSING

W	WATERFALL
BD	BEAVER DAM
SHALL	SHALLOW LAKE
MOD	MODERATE DEPTH LAKE
1	HABITAT TYPE 1
2	HABITAT TYPE 2
3	HABITAT TYPE 3
4	HABITAT TYPE 4
5	HABITAT TYPE 5

SHEET No. 7

PROPOSED ROUTE



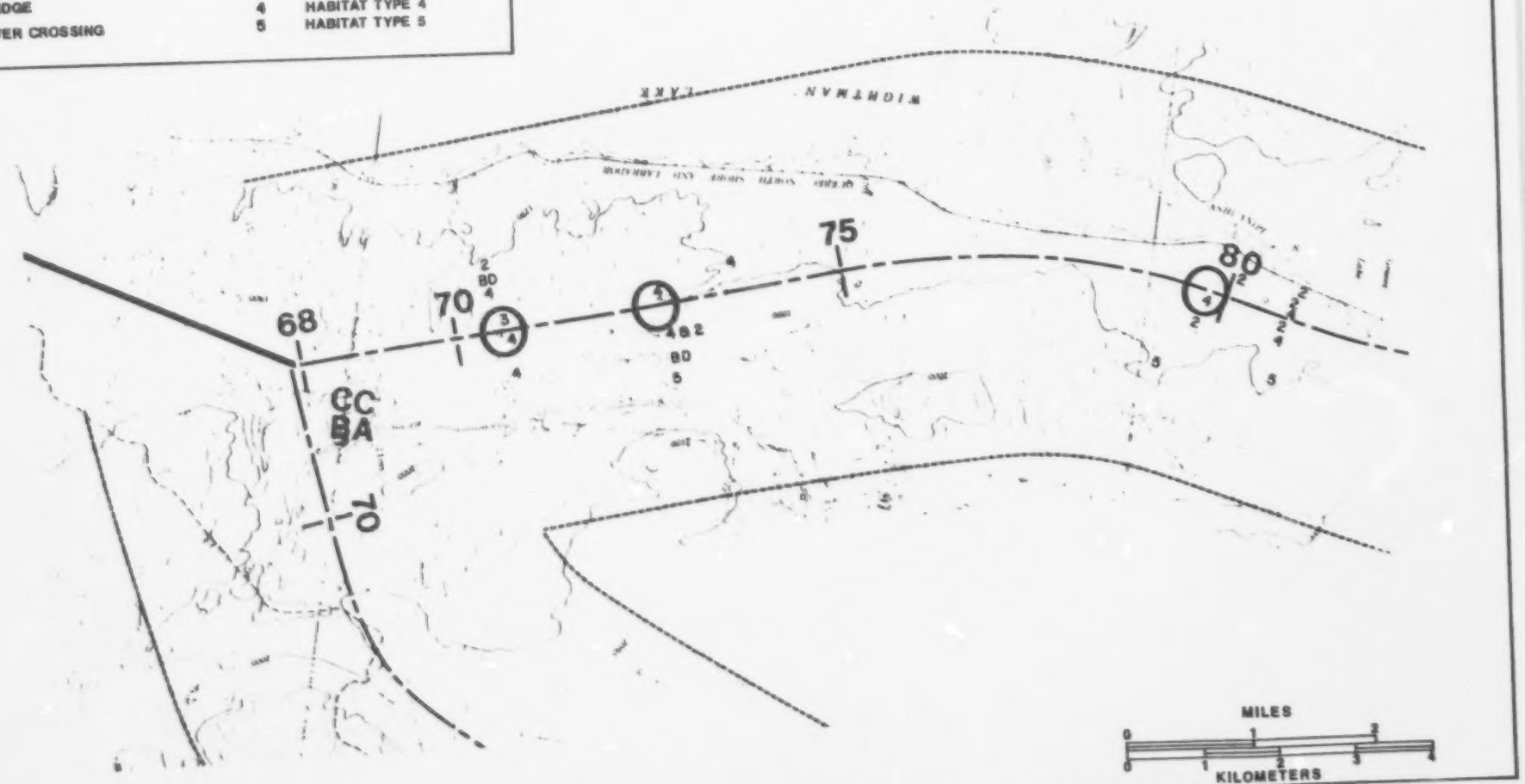
LGL LTD.

FISH HABITAT SURVEY
LEGEND

CC	CONSTRUCTION CAMP
BA	BORROW AREA
MD	MAINTENANCE DEPOT
B	BRIDGE
O	RIVER CROSSING

W	WATERFALL
BD	BEAVER DAM
SHALL	SHALLOW LAKE
MOD	MODERATE DEPTH LAKE
1	HABITAT TYPE 1
2	HABITAT TYPE 2
3	HABITAT TYPE 3
4	HABITAT TYPE 4
5	HABITAT TYPE 5

SHEET No. 8
ALTERNATE ROUTE



LGL LTD.

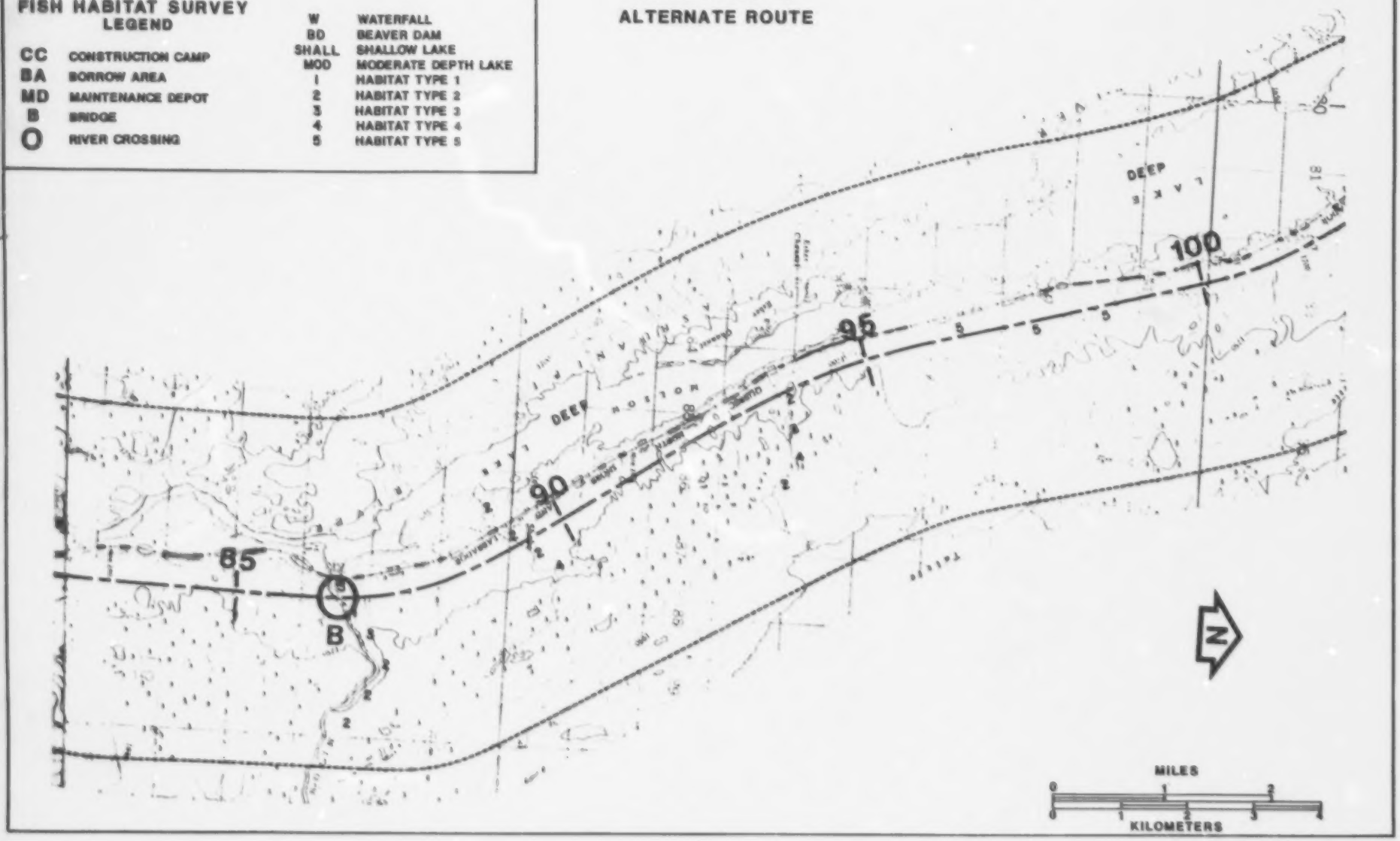
FISH HABITAT SURVEY
LEGEND

CC	CONSTRUCTION CAMP
BA	BORROW AREA
MD	MAINTENANCE DEPOT
B	BRIDGE
O	RIVER CROSSING

W	WATERFALL
BD	BEAVER DAM
SHALL	SHALLOW LAKE
MOD	MODERATE DEPTH LAKE
1	HABITAT TYPE 1
2	HABITAT TYPE 2
3	HABITAT TYPE 3
4	HABITAT TYPE 4
5	HABITAT TYPE 5

SHEET No. 9

ALTERNATE ROUTE



LGL LTD.

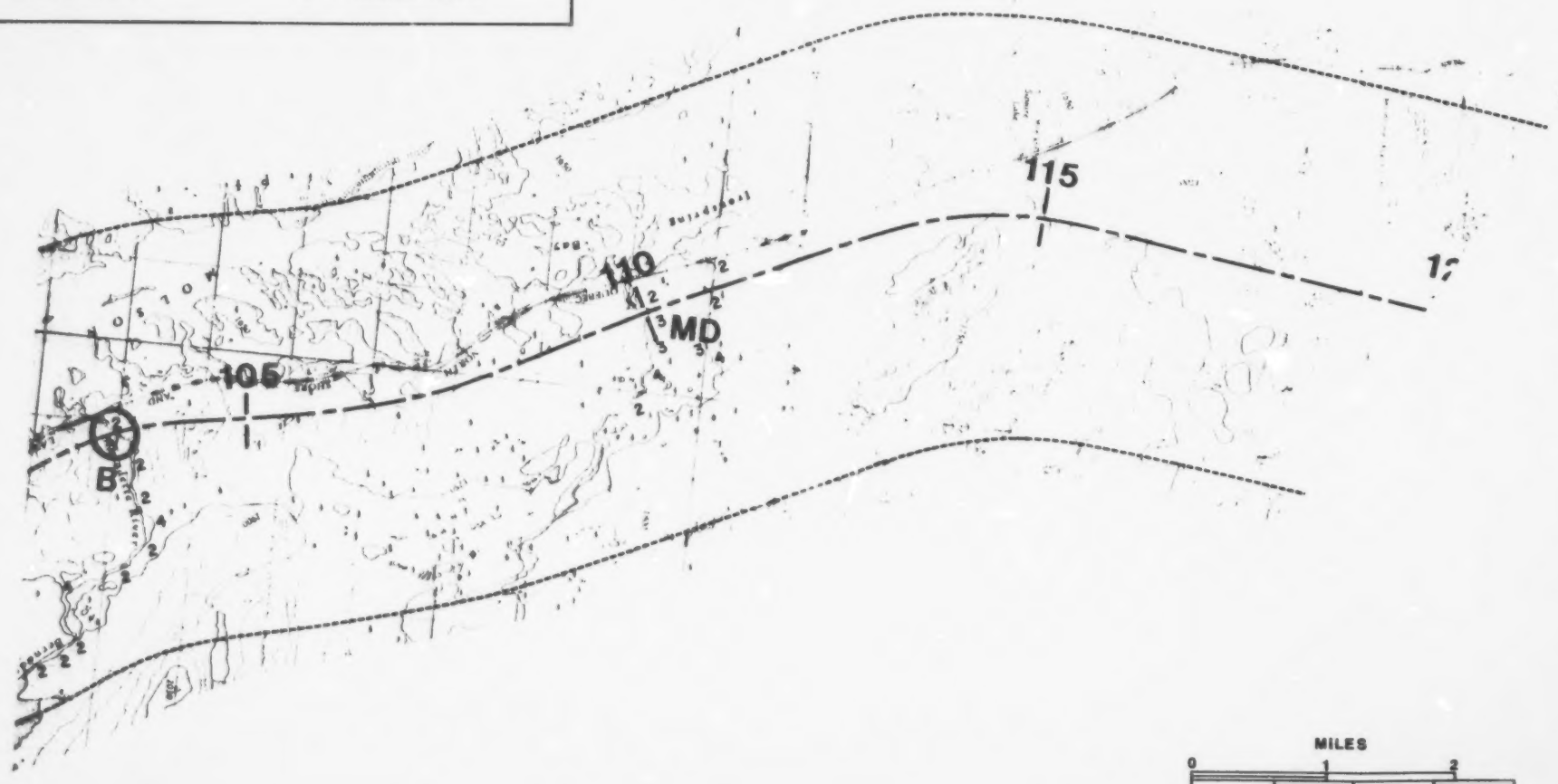
FISH HABITAT SURVEY
LEGEND

CC	CONSTRUCTION CAMP
BA	BORROW AREA
MD	MAINTENANCE DEPOT
B	BRIDGE
O	RIVER CROSSING

W	WATERFALL
BD	BEAVER DAM
SHALL	SHALLOW LAKE
MOD	MODERATE DEPTH LAKE
1	HABITAT TYPE 1
2	HABITAT TYPE 2
3	HABITAT TYPE 3
4	HABITAT TYPE 4
5	HABITAT TYPE 5

SHEET No.10

ALTERNATE ROUTE



LGL LTD.

FISH HABITAT SURVEY

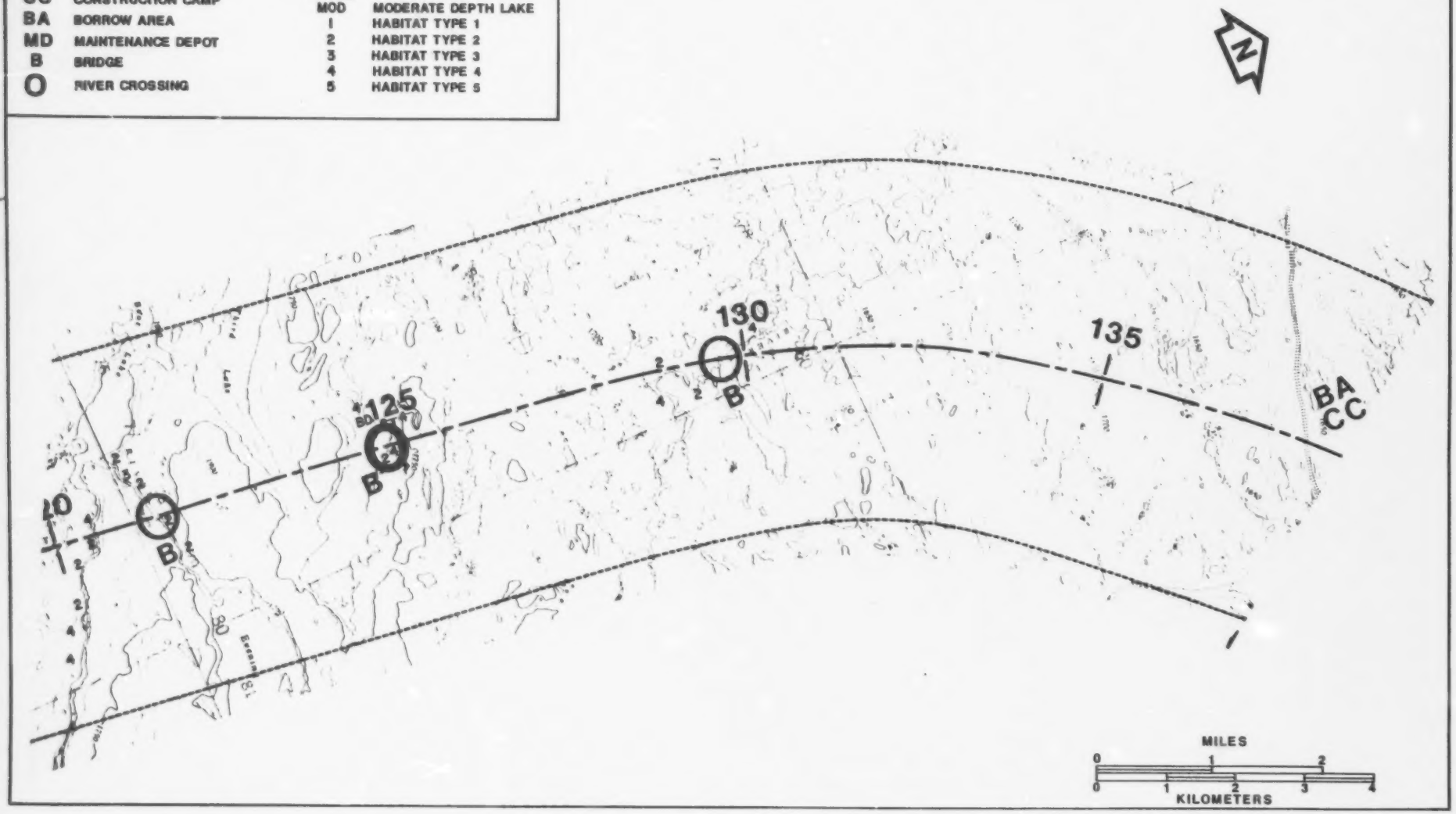
LEGEND

CC	CONSTRUCTION CAMP
BA	BORROW AREA
MD	MAINTENANCE DEPOT
B	BRIDGE
O	RIVER CROSSING

W	WATERFALL
BD	BEAVER DAM
SHALL	SHALLOW LAKE
MOD	MODERATE DEPTH LAKE
1	HABITAT TYPE 1
2	HABITAT TYPE 2
3	HABITAT TYPE 3
4	HABITAT TYPE 4
5	HABITAT TYPE 5

SHEET No.11

ALTERNATE ROUTE



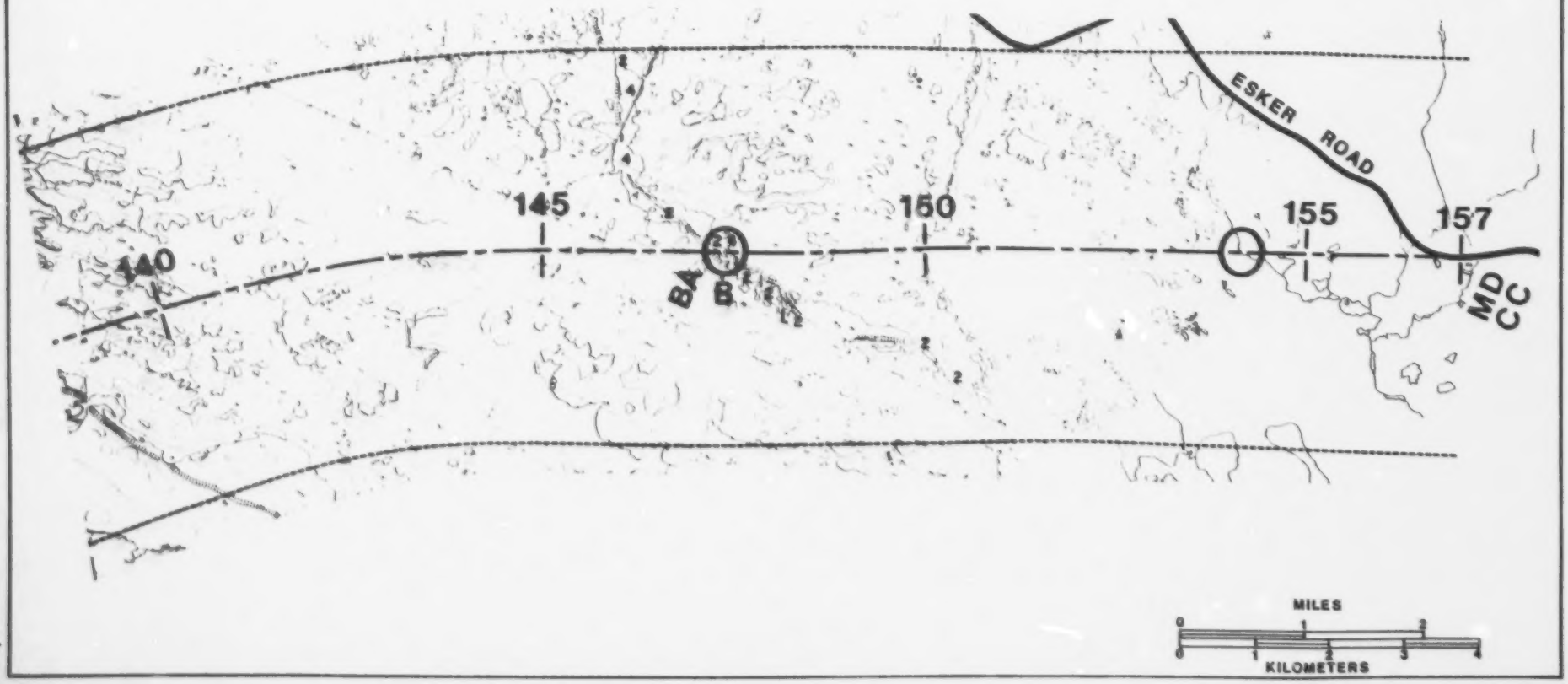
LGL LTD.

FISH HABITAT SURVEY
LEGEND

CC	CONSTRUCTION CAMP
BA	BORROW AREA
MD	MAINTENANCE DEPOT
B	BRIDGE
O	RIVER CROSSING

W	WATERFALL
BD	BEAVER DAM
SHALL	SHALLOW LAKE
MOD	MODERATE DEPTH LAKE
1	HABITAT TYPE 1
2	HABITAT TYPE 2
3	HABITAT TYPE 3
4	HABITAT TYPE 4
5	HABITAT TYPE 5

SHEET No.12
ALTERNATE ROUTE



APPENDIX 2

Stream Survey Data

Labrador Tote Road

Proposed Route

Footnotes

[1]estimated.
[2]surface velocity.
[3]approximate.
[4]inflood when measured.
[5]measurements taken 50 m upstream of center line.

STREAM SURVEY DATA

Watercourse Unnamed Km 70.5

PHYSICAL CHARACTERISTICS

Maximum Depth (cm) 56 Mean Depth (cm) 34.5

Maximum Velocity (m/s) 0.45 Mean Velocity (m/s) 0.025

Width (m) 9 Discharge m^3/s 0.078

River gradient 0.1%

Substrate Composition: boulder and silt

Apparent Stability: stable

Bank Height <1 m Bank Slope gentle

Bank Composition organic Bank Vegetation shrubs

Bank Stability no exposed erodible material Riparian Cover Nil

FISH RESOURCE

Sample Method electrofisher Effort 673 s

Catch	Species	Number	Biomass (g)
	brook trout	20	54
	burbot	1	<1

Fish Habitat Type: Type 2 downstream, Type 4 upstream

Location of Sensitive Areas: potential spawning downstream

Comments: Moderate density nursery and rearing habitat; principal concerns are siltation and fish passage.

STREAM SURVEY DATA

Watercourse Unnamed Km 72.0

PHYSICAL CHARACTERISTICS

Maximum Depth (cm) 51 Mean Depth (cm) 24.7

Maximum Velocity (m/s) 0.23 Mean Velocity (m/s) 0.108

Width (m) 3 Discharge m^3/s 0.08

River gradient 0.4%

Substrate Composition: cobble and boulder

Apparent Stability: stable

Bank Height <1 m Bank Slope gentle

Bank Composition organic Bank Vegetation spruce, alder

Bank Stability No exposed erodible material Riparian Cover extensive shade

FISH RESOURCE

Sample Method electrofisher Effort 522 s

Catch	Species	Number	Biomass (g)
	brook trout	2	8
	burbot	3	37
	lake chub	4	58

Fish Habitat Type: Type 4 upstream, Types 2 and 4 downstream

Location of Sensitive Areas: none noted

Comments: Type 4 habitat is created by beaver dams; principal concern is fish passage.

STREAM SURVEY DATA

Watercourse Unnamed Km 77.5

PHYSICAL CHARACTERISTICS

Maximum Depth (cm) 26 Mean Depth (cm) 16.4

Maximum Velocity (m/s) 0.88 Mean Velocity (m/s) 0.560

Width (m) 16 Discharge m^3/s 0.5

River gradient 0.5%

Substrate Composition: boulder

Apparent Stability: stable

Bank Height <1 m Bank Slope gentle

Bank Composition organic Bank Vegetation spruce, shrubs

Bank Stability no exposed erodible material Riparian Cover little

FISH RESOURCE

Sample Method electrofisher Effort 1099 s

Catch	Species	Number	Biomass (g)
	brook trout	3	116
	burbot	5	58
	lake chub	6	97
	sculpin	7	<7
	white sucker	4	151

Fish Habitat Type: Type 2 downstream and upstream

Location of Sensitive Areas: rapids at center line

Comments: Rapids at center line will likely create velocity barrier in culverts.

STREAM SURVEY DATA

Watercourse: Unnamed Km: 82.5

PHYSICAL CHARACTERISTICS

Maximum Depth (cm): >100 Mean Depth (cm): 66.0

Maximum Velocity (m/s): 0.22 Mean Velocity (m/s): 0.161

Width (m): 15 Discharge m^3/s: 1.59

River gradient: 0.1%

Substrate Composition: boulder

Apparent Stability: stable

Bank Height: <1 m Bank Slope: gentle

Bank Composition: organic over boulders Bank Vegetation: spruce

Bank Stability: no exposed erodible material Riparian Cover: fair

FISH RESOURCE

Sample Method: electrofisher, angling Effort: 859 s, 0.2 h

Catch	Species	Number	Biomass (g)
	brook trout	10	146
	burbot	3	24
	lake chub	6	61
	longnose dace	1	1
	pike	1	2200
	sculpin	3	10
	white sucker	2	78

Fish Habitat Type: Type 2 at crossing; Type 3 downstream

Location of Sensitive Areas: potential spawning area at lake outlet

Comments: Despite sensitive habitat at outlet, steep rapids downstream would create fish passage problems if center line moved.

STREAM SURVEY DATA

Watercourse Miron River Km 85.5

PHYSICAL CHARACTERISTICS

Maximum Depth (cm) - Mean Depth (cm) 100[1]

Maximum Velocity (m/s) - Mean Velocity (m/s) 1.7[2]

Width (m) 10[1] Discharge m^3/s 17[3]

River gradient 0.9% (upstream)

Substrate Composition: bedrock with cobble and boulder

Apparent Stability: cobble probably moves at high discharge

Bank Height 3-4 m Bank Slope steep

Bank Composition bedrock Bank Vegetation spruce

Bank Stability no exposed erodible material Riparian Cover little

FISH RESOURCE

Sample Method electrofisher Effort 627 s

Catch	Species	Number	Biomass (g)
	brook trout	2	21
	longnose dace	4	36

Fish Habitat Type: Type 3

Location of Sensitive Areas: existing chute is partial obstruction

Comments: Any flow constriction could create a complete obstruction to fish migration.

STREAM SURVEY DATA

Watercourse Unnamed River Km 88.5

PHYSICAL CHARACTERISTICS

Maximum Depth (cm) 69 Mean Depth (cm) 38.7

Maximum Velocity (m/s) 0.5 Mean Velocity (m/s) 0.287

Width (m) 12 Discharge m^3/s 1.33

River gradient 0.3%

Substrate Composition: boulder

Apparent Stability: stable

Bank Height <1 m Bank Slope gentle

Bank Composition organic Bank Vegetation shrubs

Bank Stability no exposed erodible material Riparian Cover minimal

FISH RESOURCE

Sample Method electrofisher Effort 600 s

Catch	Species	Number	Biomass (g)
	brook trout	2	5
	burbot	4	14
	lake chub	10	32
	longnose dace	3	10
	sculpin	5	12
	white sucker	1	2

Fish Habitat Type: Type 2

Location of Sensitive Areas: none observed

Comments: Density of brook trout low during this survey; principal concern is fish passage.

STREAM SURVEY DATA

Watercourse Unnamed River Km 103.0

PHYSICAL CHARACTERISTICS

Maximum Depth (cm) 34 Mean Depth (cm) 21.2

Maximum Velocity (m/s) 0.68 Mean Velocity (m/s) 0.412

Width (m) 4.5 Discharge m^3/s 0.39

River gradient 0.6%

Substrate Composition: boulder

Apparent Stability: stable

Bank Height ≤ 1 m Bank Slope gentle

Bank Composition rock and moss Bank Vegetation tall spruce and forbs

Bank Stability no exposed erodible material Riparian Cover well shaded

FISH RESOURCE

Sample Method electrofisher Effort 732 s

Catch	Species	Number	Biomass (g)
	burbot	1	4
	lake chub	4	23
	longnose dace	2	26
	sculpin	4	4

Fish Habitat Type: Type 2 and 3

Location of Sensitive Areas: none noted

Comments: Relatively poor salmonid habitat near the proposed crossing site.

STREAM SURVEY DATA

Watercourse Unnamed Km 111.5

PHYSICAL CHARACTERISTICS

Maximum Depth (cm) 35 Mean Depth (cm) 26.5

Maximum Velocity (m/s) 0.34 Mean Velocity (m/s) 0.125

Width (m) 5[4] Discharge m^3/s 0.13

River gradient 0.1%

Substrate Composition: boulder and cobble

Apparent Stability: stable

Bank Height 5 m Bank Slope gentle

Bank Composition - Bank Vegetation alder, shrubs

Bank Stability no apparent erodible material Riparian Cover overhanging alders

FISH RESOURCE

Sample Method electrofisher Effort 461 s

Catch	Species	Number	Biomass (g)
	brook trout	1	1
	burbot	2	20
	lake chub	5	39

Fish Habitat Type: poorly defined Type 5 habitat

Location of Sensitive Areas: none noted

Comments: Poor fish habitat at this site; no fish habitat related concerns.

STREAM SURVEY DATA

Watercourse Unnamed Km 114.0

PHYSICAL CHARACTERISTICS

Maximum Depth (cm) 58[4] Mean Depth (cm) 42.3

Maximum Velocity (m/s) - Mean Velocity (m/s) 1.4[2]

Width (m) 12 Discharge m^3/s 7.1[3]

River gradient 0.8%

Substrate Composition: boulder and cobble

Apparent Stability: stable

Bank Height <1 m Bank Slope gentle

Bank Composition organic Bank Vegetation shrubs

Bank Stability no exposed erodible material Riparian Cover little

FISH RESOURCE

Sample Method electrofisher Effort 189 s

Catch	Species	Number	Biomass (g)
	One fish observed none captured due to high velocity		

Fish Habitat Type: Type 2 and 3

Location of Sensitive Areas: none noted

Comments: Velocities were very high; principal concern is fish passage.

STREAM SURVEY DATA

Watercourse Unnamed Km 116.5

PHYSICAL CHARACTERISTICS

Maximum Depth (cm) 57[4] Mean Depth (cm) 28.9

Maximum Velocity (m/s) - Mean Velocity (m/s) 1.9[2]

Width (m) 12 Discharge m^3/s 6.6

River gradient 0.8%

Substrate Composition: boulder and cobble

Apparent Stability:

Bank Height Left bank: 10 m Bank Slope 40°

Right bank: 10 m

Bank Composition Morrainal deposits Bank Vegetation alders and willows

Bank Stability some erosional potential Riparian Cover extensive

FISH RESOURCE

Sample Method electrofisher Effort 545 s

Catch	Species	Number	Biomass (g)
	brook trout	7	265
	sculpin	1	2

Fish Habitat Type: Type 2

Location of Sensitive Areas: none noted

Comments: River in flood during the present survey, but would normally provide good rearing habitat.

STREAM SURVEY DATA

Watercourse Unnamed Km 122.0

PHYSICAL CHARACTERISTICS

Maximum Depth (cm) 76 Mean Depth (cm) 54.4

Maximum Velocity (m/s) 0.39 Mean Velocity (m/s) 0.206

Width (m) 15 Discharge m^3/s 1.68

River gradient 0.2%

Substrate Composition: boulder and cobble

Apparent Stability: stable

Bank Height ≤ 1 m Bank Slope gentle

Bank Composition organic Bank Vegetation spruce, larch

Bank Stability no exposed erodible material Riparian Cover well shaded

FISH RESOURCE

Sample Method angled Effort 1 h

Catch	Species	Number	Biomass (g)
	One brook trout observed		

Fish Habitat Type: Type 2

Location of Sensitive Areas: none noted

Comments: Stream appears to provide good habitat; fish passage is principal concern.

STREAM SURVEY DATA

Watercourse Unnamed Km 126.5

PHYSICAL CHARACTERISTICS

Maximum Depth (cm) 53 Mean Depth (cm) 34.1

Maximum Velocity (m/s) 0.93 Mean Velocity (m/s) 0.490

Width (m) 15 Discharge m^3/s 2.5

River gradient -

Substrate Composition: boulder and cobble

Apparent Stability: stable

Bank Height <1 m Bank Slope gentle

Bank Composition organic Bank Vegetation alder, shrubs

Bank Stability no exposed erodible material Riparian Cover good cover

FISH RESOURCE

Sample Method beach seine, angled Effort 6 hauls, 0.6 h

Catch	Species	Number	Biomass
	brook trout	2	90
	longnose sucker	1	50

Fish Habitat Type: Type 2

Location of Sensitive Areas: good rearing habitat throughout; some possible spawning habitat downstream

Comments: Fish habitat appeared to be very good despite low catch. High water rendered fishing difficult.

STREAM SURVEY DATA

Watercourse Unnamed Km 138.0

PHYSICAL CHARACTERISTICS

Maximum Depth (cm) - Mean Depth (cm) 100[1]

Maximum Velocity (m/s) - Mean Velocity (m/s) 2.5[2]

Width (m) 15[1] Discharge m^3/s 35[3]

River gradient 3.5%

Substrate Composition: large boulders

Apparent Stability: stable

Bank Height 1 m Bank Slope gentle

Bank Composition bedrock outcrop Bank Vegetation tall spruce, alders

Bank Stability no exposed erodible material Riparian Cover alders along shore

FISH RESOURCE

Sample Method beach seine, angling Effort 2 hauls, 1 h

Catch	Species	Number	Biomass (g)
	brook trout	2	88

Fish Habitat Type: Type 3 at crossings and downstream; some Type ? upstream

Location of Sensitive Areas: potential velocity barrier at crossing

Comments: Velocity barrier is likely in culverts due to steep gradient; bridge necessary unless centerline moved to lower gradient.

STREAM SURVEY DATA

Watercourse: Unnamed — Km: 144.0

PHYSICAL CHARACTERISTICS

Maximum Depth (cm): 86 — Mean Depth (cm): 42.8

Maximum Velocity (m/s): 0.93 — Mean Velocity (m/s): 0.56

Width (m): 11 — Discharge m^3/s: 2.7

River gradient: -

Substrate Composition: boulder, some gravel deposits

Apparent Stability: stable

Bank Height: Left bank: 2 m — Bank Slope: Left: 45°

Right bank: <1 m — Right: gentle

Bank Composition: organic over morrainal material — Bank Vegetation: spruce, shrubs

Bank Stability: no exposed erodible material — Riparian Cover: well shaded

FISH RESOURCE

Sample Method: electrofisher — Effort: 729 s

Catch	Species	Number	Biomass (g)
	brook trout	5	148
	burbot	2	18
	lake chub	5	44
	longnose dace	1	11
	sculpin	3	5
	white sucker	1	53

Fish Habitat Type: Type 2 with some Type 3 at proposed crossing

Location of Sensitive Areas: none noted

Comments: Rapids situated at the crossing site could cause a velocity barrier in culverts.

STREAM SURVEY DATA

Watercourse Unnamed Km 157.0

PHYSICAL CHARACTERISTICS

Maximum Depth (cm) 40[5] Mean Depth (cm) 27.6[5]

Maximum Velocity (m/s) 0.95[5] Mean Velocity (m/s) 0.686[5]

Width (m) 14[5] Discharge m^3/s 2.82[5]

River gradient 0.3%[5]

Substrate Composition: boulder and cobble

Apparent Stability: stable

Bank Height 1 m Bank Slope gentle

Bank Composition organic over fluvial deposits Bank Vegetation spruce and alder

Bank Stability no exposed erodible material Riparian Cover minimal

FISH RESOURCE

Sample Method electrofisher Effort 1073 s

Catch	Species	Number	Biomass (g)
	brook trout	1	4
	burbot	5	52
	lake chub	2	6
	longnose dace	4	11
	sculpin	8	15

Fish Habitat Type: Type 4

Location of Sensitive Areas: none noted

Comments: The proposed crossing area was flooded and over 2 m deep during this study. The sampled area is also flooded when reservoir is full.

STREAM SURVEY DATA

Watercourse: Unnamed Km: 179.0

PHYSICAL CHARACTERISTICS

Maximum Depth (cm): 98 Mean Depth (cm): 55.4

Maximum Velocity (m/s): 0.25 Mean Velocity (m/s): 0.24

Width (m): 4.5 Discharge m^3/s: 0.59

River gradient: <0.1%

Substrate Composition: cobble

Apparent Stability: stable

Bank Height: <1 m Bank Slope: gentle

Bank Composition: peat Bank Vegetation: shrubs and grass

Bank Stability: peat shoreline will erode if flow constricted Riparian Cover: Nil

FISH RESOURCE

Sample Method: angled Effort: 0.5 h

gillnet 12.0 h

Catch	Species	Number	Biomass (g)
	pike	1	2295
	white sucker	3	2447

Fish Habitat Type: Type 4

Location of Sensitive Areas: none observed

Comments: This stream provides for fish movement between two lakes.

STREAM SURVEY DATA

Watercourse Unnamed Km 186.0

PHYSICAL CHARACTERISTICS

Maximum Depth (cm) 150[1] Mean Depth (cm) 40[1]

Maximum Velocity (m/s) - Mean Velocity (m/s) 1.1[2]

Width (m) 20[1] Discharge m^3/s 8.8[3]

River gradient 2.6%

Substrate Composition: boulders

Apparent Stability: stable

Bank Height low floodplain then 3-5 m banks Bank Slope moderate

Bank Composition morrainal material Bank Vegetation alders and shrubs

Bank Stability no exposed erodible material Riparian Cover Some over-hanging alders

FISH RESOURCE

Sample Method beach seine, angling Effort 3 hauls, 1.5 h

Catch	Species	Number	Biomass
	Nil		

Fish Habitat Type: Type 3

Location of Sensitive Areas: none noted

Comments: Significant seasonal fish movements are likely; any channel constriction would probably create velocity barrier at observed flows.

STREAM SURVEY DATA

Watercourse Valley River Km 194.5

PHYSICAL CHARACTERISTICS

Maximum Depth (cm) 38 Mean Depth (cm) 21.5

Maximum Velocity (m/s) 0.84 Mean Velocity (m/s) 0.450

Width (m) 15 Discharge m^3/s 1.21

River gradient 1.8%

Substrate Composition: boulder

Apparent Stability: stable

Bank Height 5 m Bank Slope moderate

Right bank has alluvial flat

Bank Composition gravel and cobble Bank Vegetation alders and spruce

Bank Stability no exposed erodible material Riparian Cover minimal

FISH RESOURCE

Sample Method angling Effort 3.0 h

Catch	Species	Number	Biomass
	pike	1	2000

Fish Habitat Type: Type 4 and Type 3

Location of Sensitive Areas: none noted

Comments: Above measurements refer only to western (smaller) channel of river; conditions similar in eastern fork; good habitat.

APPENDIX 3

Stream Survey Data

Labrador Tote Road

Alternate Route

Footnotes

[1]estimated
[2]surface velocity
[3]approximate
[4]measured downstream of crossing

STREAM SURVEY DATA

Watercourse Miron River Km 86.5

PHYSICAL CHARACTERISTICS

Maximum Depth (cm) 100[1] Mean Depth (cm) 60[1]

Maximum Velocity (m/s) - Mean Velocity (m/s) 1.3[2]

Width (m) 60[1] Discharge m^3/s 45[3]

River gradient 2.0%

Substrate Composition: boulder and cobble

Apparent Stability: probably shifts at high discharge

Bank Height Right 10 m Bank Slope Right 60°

Left <1 m gentle

Bank Composition Right gravel Bank Vegetation spruce

Left organic alder

Bank Stability Right bank may slump Riparian Cover Nil

at high flow

FISH RESOURCE

Sample Method electrofisher Effort 678 s

Catch	Species	Number	Biomass (g)
	brook trout	4	280
	lake chub	3	21
	longnose dace	16	36
	sculpin	7	15
	white sucker	8	66

Fish Habitat Type: Type 3

Location of Sensitive Areas:

Comments: Some rearing habitat but primarily a migration route to better habitat upstream.

STREAM SURVEY DATA

Watercourse Bernadette River Km 103.5

PHYSICAL CHARACTERISTICS

Maximum Depth (cm) 78 Mean Depth (cm) 39.9

Maximum Velocity (m/s) 0.94 Mean Velocity (m/s) 0.496

Width (m) 16 Discharge m^3/s 3.6

River gradient 0.4

Substrate Composition: boulder

Apparent Stability: stable

Bank Height <1 m Bank Slope gentle

Bank Composition morraine Bank Vegetation alder and spruce

Bank Stability no exposed erodible material Riparian Cover Nil

FISH RESOURCE

Sample Method electrofisher Effort 864 s

Catch	Species	Number	Biomass (g)
	brook trout	14	55
	longnose dace	4	32
	sculpin	4	12

Fish Habitat Type: Type 2

Location of Sensitive Areas: none noted

Comments: Good brook trout habitat; considerable fish movement is anticipated.

STREAM SURVEY DATA

Watercourse: Evening River Km: 121.5

PHYSICAL CHARACTERISTICS

Maximum Depth (cm): 36 Mean Depth (cm): 12

Maximum Velocity (m/s): 0.69 Mean Velocity (m/s): 0.340

Width (m): 27 Discharge m^3/s: 1.1

River gradient: 0.5%

Substrate Composition: cobble with some gravel patches

Apparent Stability: stable

Bank Height: <1 m Bank Slope: gentle

Bank Composition: organic Bank Vegetation: spruce, larch and Willow

Bank Stability: no exposed erodible material Riparian Cover: Nil

FISH RESOURCE

Sample Method: electrofisher Effort:

Catch	Species	Number	Biomass (g)
	brook trout	8	285
	burbot	6	228
	lake chub	32	224
	longnose dace	4	22
	sculpin	9	11
	white sucker	1	7

Fish Habitat Type: Type 2

Location of Sensitive Areas: some scattered spawning gravel

Comments: The crossing area and river up and downstream provide good salamonid habitat.

STREAM SURVEY DATA

Watercourse: Unnamed — Km: 125.0

PHYSICAL CHARACTERISTICS

Maximum Depth (cm): >100 — Mean Depth (cm): -

Maximum Velocity (m/s): none detectible — Mean Velocity (m/s): -

Width (m): 20 m — Discharge m^3/s: 0.1^4

River gradient: <0.1%

Substrate Composition: organic

Apparent Stability: poor

Bank Height: <1 m — Bank Slope: flat

Bank Composition: bog — Bank Vegetation: grass and shrubs

Bank Stability: no exposed erodible material — Riparian Cover: Nil

FISH RESOURCE

Sample Method: electrofisher[4] — Effort: 765 s

Catch	Species	Number	Biomass (g)
	brook trout	1	32
	burbot	2	52
	lake chub	5	15
	longnose dace	1	7
	sculpin	6	23

Fish Habitat Type: Type 4 at crossing; Type 2 further downstream

Location of Sensitive Areas: none noted

Comments: No detectable flow at crossing site and organic substrate suggest that this is not likely to be good salmonid habitat.

STREAM SURVEY DATA

Watercourse: Wide River Km: 130.0

PHYSICAL CHARACTERISTICS

Maximum Depth (cm): 92 Mean Depth (cm): 55.4

Maximum Velocity (m/s): 0.24 Mean Velocity (m/s): 0.155

Width (m): 9 Discharge m^3/s: 0.8

River gradient: <0.1%

Substrate Composition: boulder and cobble

Apparent Stability: stable

Bank Height: 2 to 3 m Bank Slope: gentle

Bank Composition: organic soil Bank Vegetation: shrubs

Bank Stability: no exposed erodible material Riparian Cover: Nil

FISH RESOURCE

Sample Method: electrofisher Effort: 632 s

Catch	Species	Number	Biomass (g)
	burbot	3	58
	lake chub	4	45
	sculpin	6	14

Fish Habitat Type: Type 4

Location of Sensitive Areas: none noted

Comments: Poor habitat for juvenile salmonids; possible migration route.

STREAM SURVEY DATA

Watercourse Unnamed Km 147.5

PHYSICAL CHARACTERISTICS

Maximum Depth (cm) 55 Mean Depth (cm) 36.2

Maximum Velocity (m/s) 0.84 Mean Velocity (m/s) 0.459

Width (m) 26 Discharge m^3/s 4.3

River gradient 1.0%

Substrate Composition: gravel and cobble

Apparent Stability: may shift at high flow

Bank Height 2 m Bank Slope moderate

Bank Composition gravel Bank Vegetation alder and shrubs

Bank Stability gravel may erode during floods Riparian Cover Nil

FISH RESOURCE

Sample Method beach seine, observation Effort 4 hauls

Catch	Species	Number	Biomass (g)
	brook trout	1	-
	lake chub	4	2
	pike	3	-
	white sucker	24	10

Fish Habitat Type: Types 1 and 2

Location of Sensitive Areas: potential spawning both up and downstream

Comments: Excellent fish habitat in this area.